NATIONAL BUREAU OF STANDARDS REPORT

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PRELIMINARY REPORT ON THE THERMODYNAMIC PROPERTIES OF SELECTED LIGHT-ELEMENT AND SOME RELATED COMPOUNDS

(SUPPLEMENT TO NBS REPORTS 6297, 6484, 6645, and 6928)

1 January 1961

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Fifth Technicol Summary Report
to the Advanced Research Projects Agency
on the Thermodynamic Properties
of Light-Element Compounds

Reference: ARPA Order No. 20-61

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

ABSTRACT

This is the fifth report on the current experimental, theoretical, and evaluative program, at the National Bureau of Standards, on the thermodynamic properties of light-element and other compounds of primary interest in high-temperature research. This program has been expanded to include Li, Be, B, Mg, Al, Ti, and Zr, as well as their compounds with H, O, F, Cl, N, and C. The emphasis in the NBS work has been on the simpler compounds, with the aim of including not only the simplest reactants such as metals and alloys, but especially all the substances of these elements which are likely to occur as combustion products. The current report devotes considerable space to (I) a compilation and critical review for some boron compounds and (II) a preliminary review of "mixed" systems (i.e., systems and compounds containing two or more of the above seven metallic elements).

Part I, devoted to a number of boron compounds of interest in the B-O-H-X system (X = halogen), summarizes the results of assembly and review of the available data, including 52 tables, a discussion of the sources of data used, and an indication of the reliability of the values given. The preparation of this material has taken place largely as a part of older programs at the Bureau, some of which have been limited to boron compounds.

Part II, on "mixed" systems, treats (1) alloys and intermetallic compounds, (2) metal borides and boride systems, (3) mixed metal oxides, and (4) mixed metal fluorides and chlorides. Most of the discussion is based on 56 phase diagrams of these systems which have been reproduced from well-known compilations. In addition, we have begun to compile equally important properties, particularly heats of formation and densities. It should be emphasized that at present our coverage of these properties (except for the heats of formation of the borides) is preliminary and incomplete; however, the paucity of data presented reflects the present scarcity of information in this field.

Part III supplements our earlier reports on the program with some new and revised heats of formation and 16 tables of thermodynamic functions of condensed phases (revised tables for Li and LiCl, and new tables for 14 substances and solid solutions containing titanium or zirconium).

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PART I

THERMOCHEMISTRY AND THERMODYNAMIC FUNCTIONS OF SOME BORON COMPOUNDS

(by William H. Evans)

Introduction

The use of boron compounds in high-energy fuels has created a need for thermochemical and thermodynamic data for such compounds and for their combustion products. At the present time a number of sets of such thermodynamic data, selected from various sources and differing more or less among themselves, are in use [1].[1] As a consequence, calculations of equilibrium composition and performance characteristics made by different laboratories cannot be critically compared, unless it is known that in each case the same basic thermodynamic data were used.

As a part of the program of the National Bureau of Standards on the calculation and compilation of data on the chemical thermodynamic properties of chemical substances, we have assembled and reviewed the available data on the compounds of boron. This report summarizes the results for a number of compounds of interest in the B-O-H-X system, including a discussion of the sources of data used and an indication of the reliability of the values given. To increase the usefulness of the tables, several molecules have been included for which only preliminary experimental or estimated data are available.

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[1] Figures in brackets indicate literature references at the end of this paper.

Sources of data and methods of calculation used.

The chemical atomic weights used were taken from Wichers [2]. Spectroscopic data reported for specific isotopic species were adjusted [3,4] to averaged or effective constants, corresponding to the natural isotopic mixture; the molecular constants used are tabulated in tables 2 and 3. Fundamental physical constants were taken from the selected set compiled by Cohen, Crewe, and DuMond [5]. Auxiliary heat-of-formation data, unless indicated otherwise, are taken from [6]. The reference state for bromine, iodine, and sulfur is the diatomic ideal gas.

Thermodynamic functions for the condensed phases were obtained by numerical integration and differentiation of smoothed values read from large-scale plots of C_p or $(H-H_0)/T$, as appropriate. Thermodynamic functions for the gaseous species were calculated by standard methods [7,8] for the ideal-gas state at a pressure of one atmosphere. The calculations for diatomic molecules include corrections for the effects of vibrational anharmonicity, rotational stretching, and rotational-vibrational interaction. The calculations for the polyatomic molecules are for the rigid-rotator harmonic-oscillator approximation. Entropy due to nuclear spin and natural isotopic mixing is omitted.[2]

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[2] The tabulated thermodynamic functions are, in general, and especially for the gaseous molecules, given to more significant

figures than the absolute accuracy warrants. This is done to preserve the more precise increments in the functions with successive temperatures. For the monatomic and diatomic species for which adequate data exist, the accuracy in the functions will vary from about 0.005 at the lower temperatures to 0.5 at the higher temperatures. The uncertainty in the functions for the polyatomic molecules is from 10 to 100 times as great because of the less accurate RR-HO calculation employed and the lower accuracy of the input data. Where the calculations have been based upon estimated molecular data, the values may be seriously in error. For the condensed phases, the estimated accuracy is 10-50 in the last decimal place given.

In table 1 are summarized the selected "best" values for the heats of formation at 0°K and 298.15°K (25°C). Tables 4-52 give the thermodynamic functions - Gibbs free energy function, enthalpy (heat content) function, entropy, heat capacity at constant pressure, and enthalpy (heat content)-as a function of temperature for each substance.

Boron. Recent x-ray diffraction work on the crystal structures of boron [9] has indicated that the crystalline form of boron used for both the low- and high-temperature calorimetric measurements was probably the β-rhombohedral structure. The thermodynamic functions for both β-rhombohedral crystalline and amorphous boron below 300°K are based upon the heat-capacity measurements by Johnston, Hersh, and Kerr [10].

High-temperature heat-content data have been reported recently by Wise, Margrave, and Altman [11] for both crystalline and amorphous boron. We have combined their data with the low-temperature data, and extrapolated the curves to the melting point. These newer data supercede the values reported by Magnus and Danz [12], Kopp [13], Moissan and Gautier [14],

Regnault [15], Weber [16], and Robertson [17] for poorly characterized, impure material.

The values available for the entropy of amorphous boron contain an additional uncertainty because of the zero-point entropy. For this reason we have chosen the β-rhombohedral crystalline form as the standard state for boron, although the thermochemical measurements which lead to the heats of formation of the boron compounds - the decomposition of B_2H_6 and the chlorination of boron to BCl_3 - were made with amorphous boron. The heat of transition from crystalline to amorphous boron has not been measured; we have selected 0.4 kcal/mole, which is in agreement with some preliminary data on the chlorination [18a] and fluorination [18] of the two forms. The uncertainty in this value is relatively unimportant as it will cancel in any reaction not involving elemental boron.

The melting point of boron selected, 2300. ±40°K, is based upon values reported by Cueilleron [19,20], Wisnyi and Pijanowski [21], and Stull [22]. We have estimated the entropy of fusion, based on data for a number of other elements. To extend the tables into the liquid range we have assumed a constant value of 7.3 cal/deg mole for the specific heat.

The thermodynamic functions for gaseous monatomic boron were calculated by direct summation over the spectroscopic levels given by Moore [23]. The sublimation pressure of boron has been measured, using the Knudsen effusion method, by Searcy and Myers [24] between 2100 and 2400°K and by Chupka [25] between 1900 and 2200°K. Their data lead to heats of sublimation, $\Delta H_0°$, of 137.0 and 128.7 kcal/mole, respectively. Some preliminary effusion data obtained by Thorn [26] indicate a value of about 133 kcal/mole. Robson and Gilles [27] have measured the decomposition pressure of B_4C; their data lead to $\Delta H_0°$ = 134.0 kcal/mole. We have selected $\Delta Hf_0°$ = 133. ±4. kcal/mole[3] as the "best" value for B(g). Further experimental work is required to establish this value more definitely.

Thermodynamic functions for $B_2(g)$ were calculated from the molecular constants given in Herzberg [3], corrected to the average isotopic species. From spectroscopic data Gaydon [28] has estimated the dissociation energy, D_0, of $B_2(g)$ as 3.0 ±0.5 ev, or 69. ±11. kcal/mole. Chupka [25] has obtained 65. ±7. kcal/mole from mass-spectroscopic data. Adopting the latter value, we have $\Delta Hf_0°$ $B_2(g)$ = 200. ±8. kcal/mole.

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[3] Uncertainties, unless otherwise indicated, represent our estimates of the over-all uncertainty in the value, with allowance for random and systematic errors.

Boron oxides. One of the most important compounds formed in the combustion of boron-containing compounds is B_2O_3. As in the case of other metalloid oxides, crystalline and amorphous states of B_2O_3 occur; the amorphous powder is the common form. It is only recently that reliable values for the heat of formation of B_2O_3 have become available. Direct measurement of the heat of combustion of boron has given values [17,29,30,31, 32,33,34,35] ranging from -281 to 368 kcal/mole; the difficulties in determining the amount of boron burned and the state of the products, particularly if a metal or organic compound is used as an auxiliary material to promote combustion, make this an unsatisfactory method. The indirect method, in which the heat of hydrolysis to aqueous H_3BO_3 of a compound of known heat of formation, and of B_2O_3, are measured, gives much better results. Prosen, Johnson, and Pergiel [36] determined the heat of formation of B_2O_3 by this method, using B_2H_6; their data lead to $\Delta Hf°_{298}$ $B_2O_3(c)$ = -305.34 ±0.33 kcal/mole. Johnson, Miller, and Prosen [37] have checked this value, using BCl_3; their data give -305.9 ±0.5 kcal/mole, in good agreement. Both experiments involved amorphous B_2O_3 and the heat of transition discussed below. Nathan [34] and Eckstein and Van Artsdalen [35] have obtained heats of combustion in fair agreement; their data give -310. and -309. kcal/mole, respectively, with rather large uncertainties. Galchenko, Koruilov, Timofiev,

and Skuratov [28] have reported a preliminary value of -303.2 kcal/mole; no details are available as yet.

The heat of transition between crystalline and amorphous B_2O_3 is calculated from the difference in the heats of solution of the two forms, as reported by Southard [39]. The heats of solution he obtained are in good agreement with other measurements [29,30,31,40,41,42,43,44,45,46,47,48,49] on one or the other form; he is the only one to have run both forms in the same apparatus, and we have adopted the difference between his values, thus eliminating systematic errors so far as possible.

Low-temperature specific-heat data have been reported for crystalline B_2O_3 by Kelley [50] and Kerr, Hersh, and Johnston [51]. Southard [39] measured the heat content above room temperature up to the melting point, 723°K. These data were used to calculate the thermal functions, which should be of acceptable accuracy.

The situation with regard to the amorphous (or glassy) B_2O_3 is much less satisfactory. Heat-content measurements, relative to room temperature, have been reported by Southard [39], Neumann [52], Dwald [53], Regnault [54], Samsoen [55], Samsoen and Mondain-Monval [56], and Winkelmann [57]. Specific heats, to 620°K, for quenched, annealed, and slowly cooled samples were reported by Thomas and Parks [58]; the specific heats of the three samples differed markedly, especially in the 500-600°K region, depending upon the previous thermal history of the sample.

Southard's data, which are the only series extensive or precise enough to be of value, have a serious defect. He determined the heat contents, relative to room temperature, by dropping a sample of B_2O_3 in a sealed container from a known high temperature into the calorimeter. This is essentially a quenching process; the final state of the sample can vary from run to run, depending upon how well the sample at the initial state has reached thermal and chemical equilibrium (especially at temperatures below the melting point) and how fast and to what extent the sample changes, in the calorimeter, into the form stable at room temperature. The specific heats obtained from the data on the liquid should be fairly reliable, as the samples at higher temperatures should have essentially the same thermal history through the glass region and should reach the same final state.

The data for the glass (which appears to be thermally equivalent to the amorphous) and the liquid just above the melting point are much less reliable. We have combined the heat-content data in this region with heat contents obtained by graphical integration of the specific heats obtained by Thomas and Parks to derive the thermal functions tabulated. The uncertainty in these values is high; the uncertainty in the glass region carries over into the high-temperature liquid values of $S°$ and $(H°-H_0°)/T$.

An additional uncertainty is introduced through the value chosen for the heat of fusion of $B_2O_3(c)$. This is obtained from the heats of solution of the amorphous and crystalline forms at 25°C, and the heat contents of the two forms at 728°K, the melting point. It appears that the amorphous form used for the heat-of-solution measurements, while that usually found at room temperature, may not have been the same as that obtained as the final state in the heat-content experiments. If this is the case, systematic errors of from one to two cal/deg mole will be introduced into the entropy and heat content function for the liquid. Further work on this system would be most desirable.

Earlier calculations [59,60] of the thermodynamic functions for $B_2O_3(c)$ were based on a bipyramidal structure [61]. However, an examination [62] of the isotopic shifts [63,64,61] reported indicates that such a structure is unlikely, and that a "V"- or "W"-shaped structure with C_{2v} symmetry is more probable. This is confirmed by the recent electron-diffraction data reported by Akishin and Spridinov [65]. The present set of thermodynamic functions for gaseous B_2O_3 is based on a O=B-O-B=O, "V"-shaped structure [62,63,64,65,66]. The vibrational frequencies used have been taken from White, Mann, Walsh, and Sommer [66, cf 61, 63,64]. These authors assumed bond lengths of 1.34A for B-O and 1.20A for B=O, and an apex angle of 120°; the recent electron diffraction data reported by Akishin and Spridinov [65] give

1.36A, 1.20A, and 95°, respectively. The tabulated functions are based on the latter structure; the calculated values of the entropy are 0.054 cal/deg mole higher than those based on the 120° structure.

Vapor pressure measurements on liquid B_2O_3 have been reported by Scheer [67], Soulen, Sthapitanonda, and Margrave [65] (see also Soulen and Margrave [69]), Searcy and Myers [24], Speiser, Naiditch, and Johnston [70], Rentzepis and White [71], and Nesmeyanov and Firsova [72]. A third-law treatment of their data gives average values of the heat of sublimation at 0°K, $\Delta H_0°$, of 96.94, 93.93, 93.79, 94.59, 95.55, and 94.95, respectively. The slope of a log P - 1/T plot of all of the data, $\Delta H°_{1400}$ = 83. ±5. kcal, reduces to $\Delta H_0°$ = 96.3 kcal/mole. As "best" value we have taken $\Delta H_0°$ = 94.6 ±0.5 kcal/mole, based primarily on the data of [70] and [72]; this gives $\Delta Hf_0°$ $B_2O_3(g)$ = -209.3 ±0.6 kcal/mole.

Thermodynamic functions for $B_2O_2(g)$ were calculated assuming a linear O=B-B=O structure, with the B=O distance 1.20A and B-B distance 1.59A. The frequencies were taken from White, Mann, Walsh, and Sommer [66].

Mass-spectrometric studies [73] of the vapors over a mixture of B and B_2O_3 indicate that B_2O_2 is the major species present. The selected heat of formation of $B_2O_2(g)$ is based on four sets of measurements. Inghram, Porter, and Chupka [73] used a mass spectrometer to study the composition of the vapors

over a B-B_2O_3 mixture. The B_2O_2 pressures they report, when combined with the present thermal functions in a third-law treatment, give $\Delta Hf_0°$ $B_2O_2(g)$ = -108.4 ±2.5 kcal/mole. If the relative pressures of $B_2O_2(g)$ and $B_2O_3(g)$ reported are used, $\Delta Hf_0°$ = -111.7 ±2.5 kcal. Scheer [74] has studied the same system in a torsion effusion apparatus; his data lead to $\Delta Hf_0°$ = -112.8 ±2.5 kcal/mole. Searcy and Myers [24] measured the effusion of B_2O_2 and Mg from a mixture of MgO and B; from these data we calculate $\Delta Hf_0°$ $B_2O_2(g)$ = -104.7 ±8. kcal/mole. However, as Rentzepis, White, and Walsh [75] have pointed out, there are serious questions regarding the temperatures and reaction rates. If the point Searcy and Myers feel is "best" is used, $\Delta Hf_0°$ $B_2O_2(g)$ = -114.7 ±5. kcal/mole is obtained. Little weight can be given to this value. Rentzepis, White, and Walsh studied the reduction of liquid B_2O_3 with graphite to give CO(g) and $B_2O_2(g)$; they have corrected for the side reaction of reduction to boron. With their data a third-law treatment gives $\Delta Hf_0°$ $B_2O_2(g)$ = -110.8 ±2.0 kcal/mole. As the "best" value we have selected the average, -111.8 ±2.0 kcal/mole.

At higher temperatures $B_2O_2(g)$ dissociates into BO(g). Some preliminary mass-spectrometric data obtained by Chupka [25] indicate a dissociation energy of about 115. ±12. kcal/mole for $B_2O_2(g)$. This gives $\Delta Hf_0°$ BO(g) = 2. ±10. kcal/mole. Chupka has also [76] indicated a dissociation energy for BO(g) of

8 volts; this gives ΔHf_0° BO(g) = 7. ±15. kcal/mole. We have taken the average, 5. ±10. kcal/mole. The thermodynamic functions for BO(g) were calculated using molecular constants from Herzberg [3].

Boron hydrides. The boron hydrides are of interest because of their unusual structure and because of their use in preparing various high-energy compounds. Heats of formation of three of them - B_2H_6, B_5H_9, and $B_{10}H_{14}$ - have been determined by Johnson and Prosen [77,78] by measurement of the heat of thermal cracking to amorphous boron. The data for B_2H_6 replace the earlier value, obtained by the hydrolysis of $B_2H_6(g)$, reported by Roth, Börger, and Bertram [29,30,31]. Recently Skinner [79] has reported a preliminary value, obtained by the hydrolysis reaction, of 7.0 ±0.5 kcal/mole. Heat capacity data from low temperature to room temperature are available for B_5H_9 [80] and $B_{10}H_{14}$ [81,82]; thermodynamic functions for the solid and liquid were obtained from these data.

The available infrared and Raman spectral data for B_2H_6 [83,84,85,86,87,88] were used to obtain a set of vibrational frequencies, which was used in the calculation of the thermodynamic functions. The molecular structure was obtained from Hedberg and Schomaker [89,90].

The infrared and Raman spectroscopic data [91,92] summarized by Hrostowski and Pimentel [92], and the moments of inertia obtained from microwave spectroscopy by Hrostowski and Myers [93]

were used in the calculation of the thermodynamic functions for $B_5H_9(g)$.

Stewart [94] and Keller and Johnston [95] have reported infrared and Raman data for solid $B_{10}H_{14}$. These data, together with the structural data from Kasper, Lucht, and Harker [96] (as revised by Moore, Dickerson, and Lipscomb [97]), were used to calculate the thermodynamic functions for the gas. The entropy thus calculated at 378°K agrees well with that calculated from the specific heat of the solid and liquid, the heat of vaporization, the heat of fusion, and the vapor pressure (see below).

Vapor pressure data for B_5H_9 have been reported by Johnston, et al. [80], Stock and Kuss [98], and Wirth and Palmer [99]. Their data were fitted by an Antoine equation; this equation, the gas density, as calculated from the Berthelot equation, and the liquid density [99] were used in the Clapeyron equation to obtain the heat of vaporization at 25°C. The vapor pressure data were also used with thermodynamic functions in a third-law treatment. The heats of vaporization obtained by the two methods are in good agreement, 7.31 and 7.29 kcal/mole. This agreement indicates that the thermodynamic functions for the gas are not seriously in error.

The heat of vaporization of liquid $B_{10}H_{14}$ at 378°K, measured by Furukawa and Park [81], was corrected to 25°C with the thermodynamic functions to obtain ΔH_s° = 18.59 ±0.3 kcal/mole.

Shepp and Bauer [100] have estimated molecular dimensions and fundamental frequencies for $BH_3(g)$; these were used to calculate the thermodynamic functions, which are thus somewhat uncertain. McCoy and Bauer [101,102] have reported the heat of dissociation of B_2H_6 into $2BH_3$ as 28.4 ±2.0 kcal/mole at 0°C. This value was obtained from the heat of reaction of trimethylamine with diborane and tetramethyldiborane, and is subject to uncertainty. This leads to ΔHf_{298}° $BH_3(g)$ = 18. ±3. kcal/mole.

The thermodynamic functions for BH(g) were calculated with molecular constants from Herzberg [3]. Gaydon [28] has obtained 3.0 ±0.5 ev, or 69. ±10. kcal/mole, for D_0 (BH). From this, ΔHf_0° BH(g) = 116. ±10. kcal/mole.

Boron hydroxides. The heat of formation of $H_3BO_3(c)$ is easily obtained from the various values reported for the heat of solution in water [29,30,31,41,42,43,44,45,46,103,104]; all values are in good agreement. The heat of formation of aqueous H_3BO_3 is obtained from the heat of hydrolysis of B_2H_6 and BCl_3 discussed above. The thermal functions for $H_3BO_3(c)$ were calculated from the low-temperature specific heats reported by Johnston and Kerr [105].

Pistorius [106] has reviewed most of the available spectroscopic data on solid boric acid and assigned the fundamental frequencies. This assignment, which is consistent with the data in other papers [107,108,109,110] not considered by Pistorius, was used to calculate the thermodynamic functions. The structure assumed [106] was a C_{3h} planar $X(YZ)_3$, with a B-O distance of 1.36A, a O-H distance of 1.0A, and a B-O-H angle of 120°. There are some questions as to the presence of internal rotation of the OH group and the values of the OH torsion frequencies; further experimental work is necessary before a satisfactory set of thermodynamic functions can be calculated.

Above room temperature H_3BO_3 rapidly loses water to form one of the metaboric acids. By using a water-vapor pressure higher than the dissociation pressure, von Stackelberg, Quatram, and Dressel [43] were able to repress the decomposition and thus measure the vapor pressure of the orthoboric acid. Their data give a heat of sublimation at 25°C of 23.55 ±2.5 kcal/mole.

Metaboric acid, HOBO, is formed in the dehydration of orthoboric acid; three cyrstalline forms are known [111]. From values of the decomposition pressures of H_3BO_3 [112,113,114, 115,116,117,118] and the heats of solution of the various forms in water [43,119,120] or aqueous sodium hydroxide [29,30,31, 119,120] we have calculated the heats of formation of the various crystalline forms.

White, Mann, Walsh, and Sommer [121] have studied the infrared spectrum of gaseous HOBO and selected the fundamentals. We have used their assignment and a structure with a B=O distance of 1.20A, a B-O distance of 1.34A, a O-H distance of 1.0A, a O=B-O angle of 180°, and a B-O-H angle of 120° in calculating the thermodynamic functions. It must be noted that these functions are rather uncertain.

Chupka and Berkowitz [122] have reported equilibrium constants for the reaction

$$H_2O(g) + B_2O_3(liq) = 2HOBO(g)$$

in the temperature range 1140-1420°K. A third-law treatment of their data gives $\Delta Hf_0°$ HOBO(g) = -134.2 ±2.0 kcal/mole. From the average value of the slope of a log K - 1/T plot, ΔH = 80. ±8. kcal/mole at 1250°K, $\Delta Hf_0°$ HOBO(g) = -134.3 ±3.0 kcal/mole. White, Mann, Walsh, and Sommer [121] have obtained from their data a slope, ΔH = 78.0 ±5.0 kcal/mole at 1350°K, for the same reaction; this gives $\Delta Hf_0°$ HOBO(g) = -134.9 ±3.0 kcal/mole. As "best" value we have selected -134.5 ±2.5 kcal/mole.

The trimer, $(HOBO)_3$ has been identified with the mass spectrometer as a minor species in the gas phase in the B_2O_3-H_2O system [122]. White, Mann, Walsh, and Sommer [121] have estimated frequencies and structure, which we have used to obtain the thermodynamic functions tabulated. They have also calculated a tentative value for the heat of formation.

Boron halides. The thermodynamic functions for gaseous BF were calculated using molecular constants from Chrétien [123,124] and Onaka [125]; those for BCl and BBr are based upon data from Herzberg [3]. The dissociation energy of BF, D_0 = 196. ±6. kcal/mole, was obtained by Gaydon [28] from extrapolation of the $A^1\Pi$ state; he prefers this to the much lower value obtained from a ground-state extrapolation, because of ionic contributions to the ground state. In a similar way he obtains D_0 = 117. ±6. kcal/mole for BCl and D_0 = 96.9 ±5. kcal/mole for BBr.

The thermodynamic functions for $BF_3(g)$ were calculated using the fundamental frequencies from Lindeman and Wilson [126], McKean [127], Nielsen [128], and Susz and Wuhrmann [129]; a D_{3h} structure with a B-F distance [90, 128,130] of 1.295A was used. The functions for $BCl_3(g)$ were calculated in a similar way, with the frequencies from Lindeman and Wilson [126], Anderson, Lassettre, and Yost [131], Scruby, Lacher, and Park [132], Wagner [133], and Cassie [134], and a D_{3h} structure with a B-Cl distance [90,130,135] of 1.73A. These functions should be reliable, within the limits of the RR-HO approximation.

The vibrational frequencies for $BBr_3(g)$ were based on the measurements of Wentink and Tiensuu [136] and Lindeman and Wilson [126]. The structure was taken as [90] D_{3h}, with a B-Br distance of 1.87A. The frequencies for $BI_3(g)$ are from Wentink and Tiensuu [136]; the B-I distance was estimated as 2.2A based on data for the silanes and aluminum halides [90].

Two preliminary values, obtained by direct fluorination of elemental boron, have recently been reported for the heat of formation of $BF_3(g)$. Wise and Hubbard [137] obtained $\Delta Hf_{298}°$ $BF_3(g)$ = -269.94 kcal/mole; Gross, Hayman, Levi, and Stuart [18] give -270.8 and -271.6 kcal/mole for two different boron samples. Enough details are not available to allow us to choose between these two values. The previous value depends upon the heat of solution of $BF_3(g)$ in water, as measured by Hammerl [138] and Laubengayer, Sears, and Finlay [139,140], and the heat of solution of B_2O_3 in aqueous HF (Mulert [141]) or the heat of reaction of $H_3BO_3(aq)$ with HF(aq) (Thomsen [46]). The analysis of the available data is complicated by the partial hydrolysis of the BF_3 to form BF_3OH^-, $BF_2(OH)_2^-$, etc., and the formation of BF_4^- (see Ryss, et al. [142]); the data reported are not extensive or detailed enough to allow correction for the effects of such reactions, or to permit the various reported heats to be referred to a common basis. If the data of Thomsen [46] for the reaction of equivalent amounts of H_3BO_3 and HF solutions are used, a heat of formation for $BF_3(g)$ of -267.8 kcal/mole is obtained. If his data obtained from experiments involving a 1/3 excess of HF are used, -270.0 kcal/mole is obtained. We have selected -270.0 kcal/mole for the present; more experimental data are required before a definitive value can be selected.

The situation with respect to $BCl_3(g)$ is much more satisfactory. Hydrolysis of either the liquid or the gas apparantly proceeds completely to give an aqueous solution of HCl and H_3BO_3. The direct determination of the heat of chlorination of amorphous boron [37] gives ΔHf_{298}° $BCl_3(liq)$ = -102.7 ±0.4 kcal/mole. The value reported by Troost and Hautefeuille [143,144], -103.3 kcal/mole, is in fortuitous agreement; apparently a systematic calibration error compensates for the impure sample used. The values obtained from the heat-of-solution measurements reported by Skinner and Smith [145] (-102.5 kcal/mole), Berthelot [146] (-103.6 kcal/mole), and Laubengayer and Sears [139] (-102.4 kcal/mole) are in good agreement; the data reported by Kapustinskiĭ and Samoĭlov [147] lead to -96.3 kcal/mole and are apparently in error. Lacher, Scruby, and Park [148] measured the heat of the gas-phase chlorination of diborane to yield BCl_3 and HCl at about 80°C. Their data, corrected to 25°C, give ΔHf_{298}° $BCl_3(liq)$ = -107.1 kcal/mole.

Berthelot [146] measured the heat of hydrolysis of liquid BBr_3; his data lead to ΔHf_{298}° $BBr_3(liq)$ = -52.0 kcal/mole. Pohland [149] studied the same reaction; his data give -54.8 kcal/mole. Skinner and Smith [150] also studied this reaction; their data give -57.45 ±0.5 kcal/mole. We have taken ΔHf_{298}° $BBr_3(liq)$ = -57.4 ±0.8 kcal/mole, with $Br_2(liq)$ as the

standard state. Correction to $Br_2(g)$ as the standard state [6,151] gives ΔHf_{298}° $BBr_3(liq)$ = -68.5 ±0.8 kcal/mole. The vapor pressure data reported by Holms [152], Apple and Wartik [153], Pohland [149], and Cueilleron [19] were used to obtain the heat of vaporization, 8.1 kcal/mole. This gives ΔHf_{298}° $BBr_3(g)$ = -60.4 ±0.9 kcal/mole. Koski, Kaufman, and Pachucki [154] have estimated, from appearance potentials, an average B-Br bond energy of 3.77 ±0.1 ev; this gives ΔHf_0° $BBr_3(g)$ = -59.5 kcal/mole, in good agreement with -60.37 kcal/mole at 0°K from the calorimetric data.

The heat of formation of $BI_3(g)$ was calculated from the average bond energy, 2.77 ev, obtained by Koski, Kaufman, and Pachucki [154]; ΔHf_0° $BI_3(g)$ = -5.4 ±8.0 kcal/mole, based on $I_2(g)$ as the standard state.

Spectroscopic data for the mixed gaseous halides, BF_2Cl, $BFCl_2$, BF_2Br, $BFBr_2$, BCl_2Br, and $BClBr_2$ have been reported by Lindeman and Wilson [126]; data for BCl_2Br and $BClBr_2$ are also available from Goubeau, Richter, and Becher [155]. We have used these frequencies and the bond lengths from BF_3, BCl_3, and BBr_3 to calculate the thermodynamic functions; all molecules are assumed to have a planar C_{2v} structure, with all X-B-X angles equal to 120°.

The equilibrium data reported by Higgins, Leisegang, Raw, and Rossouw [156], and by Gunn and Sanborn [157] involving $BFCl_2$ and BF_2Cl were used to estimate the deviations from additivity of

average bond energies; the adjustments were about 0.8 kcal/mole. The equilibrium measurements reported by Goubeau, Richter, and Becher [155] for the disproportionation reaction

$$BBr_3 + BCl_3 = BBrCl_2 + BBr_2Cl$$

lead to ΔH_0° = 0. ±0.5 kcal/mole. Therefore, average bond energies, which assume a zero heat for this type of reaction, were used to estimate the heats of formation of the remaining trihalides.

Thermodynamic functions for the dihalides BF_2, BCl_2, and BFCl, whose existence has been postulated, are based upon estimated frequencies obtained from force constants [158] transferred from the trihalides, and a non-linear structure with an X-B-X angle of 120°. Bond lengths from BCl_3 and BF_3 were used. The electronic multiplicity of the ground state is 2. Heats of formation were estimated from average bond energies. All values are to be regarded as very uncertain.

Thermal functions for $B_2Cl_4(g)$ were calculated from the molecular data reported by Mann and Fano [159]. A 2-fold barrier of 1800 calories was used [160,161] in computing the effects of the internal rotation. At 220°K the statistical calculation gives 79.086 cal/deg mole for the entropy of the gas. Linevsky and Wartik [162] obtained 52.86±0.20 cal/deg mole for the liquid at this temperature from their low-temperature calorimetric measurements. The vapor pressure data reported by Urry, Wartik, Moore, and Schlesinger [163] were used to obtain

the entropy of vaporization at 220°K to the ideal gas state, $S°_g - S°_{liq}$ = 26.46 ±.31 cal/deg mole. The third law entropy, 79.32 ±0.37 cal/deg mole, agrees within the estimated uncertainty with the statistical calculation. Gunn, Green, and Von Egidy [164] have measured the heat of chlorination of B_2Cl_4(liq) to BCl_3. Their data, combined with the heat of vaporization [163] give $\Delta Hf_{298}°$ B_2Cl_4(g) = -118.7 ±2.0 kcal/mole.

Boron oxyhalides. When BF_3 is passed over solid or liquid B_2O_3, volatile products are formed. Jones [165], Hildenbrand [166], Farber [167], and White [168] have studied this reaction. Their data lead to -571, -567, -567, and -560 kcal/mole, respectively, for $\Delta Hf_{298}°$ of $(BOF)_3$(g). Magee [169] has measured the heat of solution of solid boron oxyfluoride in water and methanol; his data, when combined with the appropriate heats of solution and formation for BF_3 and B_2O_3, lead to $\Delta Hf_{298}°$ $(BOF)_3$(c) = -588. kcal/mole. Decomposition pressure studies on the solid lead to a value of -578. kcal/mole. These give $\Delta Hf_{298}°$ $(BOF)_3$(g) = -573. and -563 kcal/mole, respectively. White [168] studied the reaction of liquid B_2O_3 with solid MgF_2 at high temperatures; his data give $\Delta Hf_{298}°$ = -567. kcal/mole. These are all preliminary values; we have taken $\Delta Hf_{298}°$ = 567. ±8. kcal/mole as the present "best" value for the gas. Sarner and Warlick [170] have estimated frequencies for this model, assuming a ring of alternating B and O atoms, with D_{3h} symmetry. All angles were assumed to be 120°; bond lengths were taken as B-O, 1.36A, B-F, 1.30A. The frequencies used were selected to agree with the ring frequencies used for $(HOBO)_3$. All data for this material are only tentative.

The monomer BOF has been postulated as a possible species at high temperature. We have estimated the frequencies by analogy with the isoelectronic molecule FCN, and with BF_3 and B_2O_2 and B_2O_3. A linear structure, with a B=O distance of 1.20A and a B-F distance of 1.28A were used to calculate the thermodynamic functions. The heat of formation was estimated from average bond energies as $\Delta Hf_0°$ BOF(g) = -140. ±8. kcal/mole. White [168] has reported that preliminary data, still unconfirmed, indicate a lower limit of about -144. kcal. All values tabulated for the BOF compounds must be regarded as provisional.

When BCl_3(g) is passed over B_2O_3, $(BOCl)_3$ is formed [171]. We have estimated the molecular data as was done for $(BOF)_3$. The functions for the monomer BOCl were estimated as for BOF. The heats of formation are based upon some preliminary transpiration data obtained by Margrave [171]; average bond energy calculations check them. Nevertheless, all data for BOCl and $(BOCl)_3$ must be regarded as provisional.

Miscellaneous compounds. Thermodynamic functions for BS(g) were calculated from molecular constants given by Zeeman [172]. Gaydon [28] selecte D_0 (BS) = 5.1 ev; based on S_2(g) as standard state, with a dissociation energy of 3.6 ev for S_2 [8,173], this gives $\Delta Hf_0°$ BS(g) = 56. ±12. kcal/mole.

The thermodynamic functions for BN(g) were calculated with the molecular constants given by Douglas and Herzberg [174]. Gaydon [28] has selected D_0 (BN) = 92. ±10. kcal/mole; from this

$\Delta Hf_0°$ BN(g) = 154. ±13. kcal/mole (D_0 (N_2) = 225. kcal/mole [175]).

Thermodynamic functions for solid BN to 300°K have been calculated from the low-temperature specific-heat data reported by Dworkin, Sasmor, and Van Artsdalen [176]. Recently Westrum [177] has repeated these measurements on a sample of higher purity; at 298.15°K he reports Cp = 4.71_3 cal/deg mole, S° = 3.35_7 cal/deg mole, and $(H°-H_0°)/T = 2.10_5$ cal/deg mole. The details of this work have not appeared, as yet, and the tabulated functions have not been revised; the differences are not large. Above room temperature, the heat-content data reported by Magnus and Danz [12] and McDonald and Stull [178] were used; the functions have been extrapolated from 1700°K to the approximate melting point of about 3000°C [179].

The heat of combustion of BN(c) in an oxygen bomb has been measured by Dworkin, Sasmor, and Van Artsdalen [176]. Their data give $\Delta Hf°_{298}$ BN(c) = -60.3 kcal/mole. Galchenko, Koruilov, Temofiev, and Skuratov [38] have reported -60.7 kcal/mole; details are not given and it is not clear if this was obtained by the combustion of boron in nitrogen, by combustion of BN in oxygen, or by some other reaction. Hubbard [137], from combustion of B and BN in F_2 in a bomb, has obtained -60.8 ±0.5 kcal/mole. Stull [22] from the combustion of B and BN in NF_3 in a bomb, has obtained -61. ±2. kcal/mole. Haldeman [180] has obtained -61. ±2. kcal/mole from combustion in an oxygen bomb. These latter three values are only preliminary. Dreger, Dadape, and

Margrave [181] have studied the decomposition pressure of BN in a Langmuir apparatus, using a microbalance over the range 1400-2000°K. There is some question as to the proper value of the accomodation coefficient to be used; they find the most satisfactory fit is obtained with an α of about $5.6 \cdot 10^{-3}$, which gives ΔHf°_{298} BN(c) = -60.8 ±1.7 kcal/mole. Pending completion of the work mentioned above, we have taken ΔHf°_{298} BN(c) = -60.3 ±0.5 as the "best" value. All of the values for BN(c) are subject to some revision, as the unpublished data mentioned above become available; such revisions should be relatively minor, however.

Thermodynamic functions for gaseous borazine, $B_3N_3H_6$, were calculated using the spectroscopic assignment of Crawford and Edsall [183]. The molecular symmetry is D_{3h}, a planar hexagon with B-N = 1.44A, B-H = 1.20A, N-H = 1.02A, and all angles 120° [90]. The heat of combustion of liquid $B_3N_3H_6$ has been determined by Kilday, Johnson, and Prosen [183]; their data give ΔHf°_{298} $B_3N_3H_6$(liq) = -131.1 ±1.3 kcal/mole. The vapor-pressure data reported by Stock and Pohland [184], Stock, Wiberg, and Martini [185], and Wiberg and Bolz [186] were used to calculate the heat of vaporization, 6.94 kcal/mole. This gives ΔHf°_{298} $B_3N_3H_6$(g) = -124.2 ±1.4 kcal/mole.

Thermodynamic functions for $B_4C(c)$ are based upon the low-temperature (55 - 255°K) specific heats reported by Kelly [50] and the high-temperature heat-content data obtained by King [187]. Because of the very low specific heat at 50°K, the extrapolation to 0°K, although long, introduces little uncertainty in the tabulated values. The heat of combustion has been measured by Smith, Dworkin, and Van Artsdalen [188]; this gives ΔHf°_{298} $B_4C(c)$ = -12.2 ±2.4 kcal/mole.

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Table 1. Heats of formation, $\Delta Hf°$.

	0°K	298.15°K
	kcal/mole	kcal/mole
B(c)	0	0
B(amorphous)		0.4 (defined)
B(g)	133. ±4.	134.22
B_2(g)	200. ±9.	201.513
BO(g)	5. ±10.	5.748
B_2O_2(g)	-108. ±3.	-107.79
B_2O_3(g)	-209.28 ±0.60	-210.14
(gls)		-300.98 ±0.30
(c)	-303.878	-305.34 ±0.33
BH(g)	116. ±10.	116.762
BH_3(g)	18.91	18. ±3.
B_2H_6(g)	11.352	7.53 ±0.25
B_5H_9(g)	21.955	15.02 ±0.40
(liq)	11.167(c)	7.74 ±0.42
$B_{10}H_{14}$(g)	13.93	2.8 ±1.5
(c)	-5.492	-15.8 ±1.5
HOB=O(g)	-134.5 ±2.0	-135.32
(c,I)		-192.56 ±0.55
(c,II)		-190.65 ±0.65
(c,III)		-189.02 ±0.65
H_3BO_3(g)	-235.68	-238.6 ±2.5
(c)	-258.929	-262.16 ±0.32

Table 1. Heats of formation, $\Delta Hf°$ (Continued).

	0°K	298.15°K
	kcal/mole	kcal/mole
$(HOBO)_3$(g)	-537. ±10.	-541.7
BF(g)	-44.6 ±6.5	-43.867
BF_2(g)	-135. ±6.	-134.84
BF_3(g)	-269.33	-270.0 ±2.5
BOF(g)	-140. ±8.	-139.9
$(BOF)_3$(g)	-564.7	-567. ±8.
(c)		-582. ±8.
BCl(g)	44.1 ±6.5	44.831
BCl_2(g)	-20. ±5.	-19.62
BCl_3(g)	-96.892	-97.11 ±0.40
(liq)		-102.71 ±0.40
B_2Cl_4(g)	-118.59	-118.7 ±2.
BOCl(g)	-85. ±5.	-84.8
$(BOCl)_3$(g)	-400. ±20.	-402.0
BFCl(g)	-78. ±6.	-77.81
BF_2Cl(g)	-211.1	-211.65
$BFCl_2$(g)	-153.6	-153.97
BBr(g)	58.8 ±6.5	59.498
BBr_2(g)	4. ±5.	
BBr_3(g)	-60.38	-60.4 ±0.9
(liq)		-68.5 ±0.80

Table 1. Heats of formation, ΔHf° (Continued).

	0°K	298.15°K
	kcal/mole	kcal/mole
$BF_2Br(g)$	-198.2 ±4.	-198.71
$BFBr_2(g)$	-129.3 ±4.	-129.59
$BCl_2Br(g)$	-84.7 ±4.	-84.87
$BClBr_2(g)$	-72.6 ±4.	-72.70
$BI_3(g)$	-5.4 ±8.	-5.29
BS(g)	56. ±12.	56.724
BN(g)	153. ±13.	153.749
(c)	-59.614	-60.3 ±0.5
$B_3N_3H_6(g)$	-118.10	-124.2 ±1.4
(liq)		-131.1 ±1.3
$B_4C(c)$	-12.130	-12.2 ±2.4

All Br compounds based on ΔHf° $Br_2(g)$ = 0.

BI_3 based on ΔHf° $I_2(g)$ = 0.

BS based on ΔHf° $S_2(g)$ = 0 and
D_0 (S_2) = 3.6 ev (83.0 kcal/mole).

Table 2. Molecular constants for diatomic molecules.

	B_e	α_e	$(10^6)D_e$	$\omega_e x_e$	ω_e	Electronic multiplicity
	cm^{-1}	cm^{-1}	cm^{-1}	cm^{-1}	cm^{-1}	
B_2	1.233	0.014	6.62+	9.56	1060.5	3
BO	1.7986	0.01673	6.48+	11.89	1895.1	2
BH	12.036	0.413	1220.	49.	2368.	1
BF*	1.5278	0.0168	7.	11.97	1410.05	1
BCl	0.6907	0.00656	1.79	5.16	843.33	1
BBr	0.497	0.0036	1.0	3.57	689.04	1
BS	0.80467	0.00516	1.48+	6.39	1187.41	2
BN	1.682	0.025	8.22+	12.4	1522.	6

*$\beta_e = -1.5 \cdot 10^{-4}$, $y_e \omega_e = 0.057$

+Estimated as $D_e = (4B_e^3/\omega_e^2)$

Table 3. Vibrational frequencies and moments of inertia for polyatomic molecules.

	Frequencies	Moments of inertia
	cm^{-1}	$g\ cm^2 \cdot 10^{-39}$
	(Degeneracies, real or apparent, indicated in parentheses.)	
B_2O_2	2000, 1890, 750, 600(2), 300(3)	[B_0 = 0.1195 cm^{-1}]
B_2O_3	2045(2), 1418, 877, 310, 764, 744, 1306, 875	22.0397, 5.4330, 24.4727
BH_3	2384, 802, 2976(2), 1764(2)	0.33778, 0.33778, 0.67557
B_2H_6	2526, 2105, 1181, 798, 830, 1763, 1037, 2615, 1177, 950, 369, 2594, 922, 1916, 974, 2522, 1604, 1012	1.051, 4.575, 4.959
B_5H_9	799, 985, 1126, 1413, 1844, 2600(3), 500, 1450, 782, 900, 1387, 1870, 470, 1100, 1500, 738, 568(2), 605(2), 700(2), 882(2), 1034(2), 1449(2), 1621(2), 1802(2), 2598 (2)	11.836, 11.836, 17.30
$B_{10}H_{14}$	230, 295, 344, 350, 387, 434, 446, 452, 464, 508, 588, 618, 635, 651, 690, 701, 709, 720, 747, 752, 767, 773, 814, 822, 832, 859, 862, 903, 915, 921, 924, 938, 942, 960, 967, 972, 1008, 1037, 1060, 1104, 1160, 1190, 1210, 1250, 1300, 1360, 1390, 1410, 1460, 1500, 1555, 1590, 1620, 1665, 1880(2), 1929(2), 2550(2), 2576(2), 2595(2), 2618(2)	48.940, 57.268, 37.573
HBO_2	3680, 2030, 1420, 1250, 600, 700	9.1052, 9.2207, 0.1155

Table 3. Vibrational frequencies and moments of inertia for polyatomic molecules (Continued).

	Frequencies	Moments of inertia
	cm^{-1}	g $cm^2 \cdot 10^{-39}$
H_3BO_3	3250, 881, 1060, 652, 824, 1440(2), 3180(2), 1185(2), 210(2), 544(2)	8.3308, 8.3308, 16.6616
$(HBO_2)_3$	550, 1150, 950, 3500, 1100, 500, 600, 250, 500, 350, 750(2), 900(2), 1300(2), 1000(2), 600(2), 450(2), 3500(2), 350(2), 200(2), 1000(2)	44.397, 44.397, 88.794
BF_2	1450, 890, 480	0.591, 7.996, 8.587
BF_3	888, 696.7, 1463.3(2), 480.7(2)	7.9364, 7.9364, 15.8728
BOF	1000, 420(2), 1900	[BO = 0.31466 cm^{-1}]
$(BOF)_3$	900(3), 400(3), 1050(6), 450(6), 250(3)	45.833, 45.833 91.667
BCl_2	960, 470, 240	1.166, 26.427, 27.593
BCl_3	471, 458.5, 960.9(2), 243(2)	26.4275, 26.4275, 52.9550
B_2Cl_4	1131, 401, 225, 730, 291, 917(2), 617(2), 180(2)	163.468, 98.237, 98.237
BOCl	500, 390(2), 1900	[BO = 0.17129 cm^{-1}]
$(BOCl)_3$	470(3), 390(3), 1050(6), 450(6), 250(3)	96.67, 96.67, 193.34
BFCl	1450, 340, 960	.784, 14.896, 15.680
BF_2Cl	1250, 697, 429, 1430, 366, 608	7.936, 22.375, 30.311

Table 3. Vibrational frequencies and moments of inertia for polyatomic molecules (Continued).

	Frequencies	Moments of inertia
	cm^{-1}	$g\ cm^2 \cdot 10^{-39}$
$BFCl_2$	1320, 554, 266, 1000, 339, 528	26.427, 11.875, 38.302
BBr_3	279, 374, 825.7(2), 151(2)	69.595, 69.595, 139.190
BF_2Br	1215, 633, 330, 1426, 346, 572	7.936, 28.943, 36.879
$BFBr_2$	1309, 418, 183, 869, 283, 496	69.595, 14.846, 84.441
$BBrCl_2$	885, 405, 958, 218, 208, 433	26.427, 47.234, 76.661
BBr_2Cl	924, 343, 165, 834, 195, 408	36.564, 69.595, 104.159
BI_3	190, 339, 710(2), 100(2)	152.97, 152.97, 305.94
$B_3N_3H_6$	851, 938, 2535, 3450, 800, 1100, 415, 1650, 622, 1098, 525(2), 717(2), 917(2), 1466(2), 1610(2), 2519(2), 3400(2), 288(2), 798(2), 1070(2)	16.0899, 16.0899, 32.1798

Table 4. B(crystal)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
0.	0.0	0.0	0.0	0.0	0.0
50.	0.004	0.004	0.008	0.018	0.2
100.	0.020	0.061	0.081	0.256	6.1
150.	0.069	0.206	0.275	0.772	30.9
200.	0.157	0.430	0.587	1.447	86.0
250.	0.283	0.701	0.984	2.107	175.2
300.	0.434	0.984	1.418	2.667	295.2
350.	0.60	1.27	1.87	3.24	444.
400.	0.80	1.54	2.34	3.72	616.
450.	1.00	1.80	2.80	4.10	810.
500.	1.20	2.05	3.25	4.40	1025.
600.	1.61	2.48	4.09	4.87	1488.
700.	2.02	2.85	4.87	5.22	1995.
800.	2.42	3.17	5.59	5.51	2536.
900.	2.81	3.44	6.25	5.74	3096.
1000.	3.19	3.68	6.87	5.92	3680.
1100.	3.55	3.89	7.44	6.07	4279.
1200.	3.89	4.08	7.97	6.19	4896.
1300.	4.23	4.24	8.47	6.30	5512.
1400.	4.55	4.39	8.94	6.40	6146.
1500.	4.86	4.53	9.39	6.48	6795.
1600.	5.16	4.65	9.81	6.56	7440.
1700.	5.44	4.77	10.21	6.63	8109.
1800.	5.72	4.87	10.59	6.70	8766.
1900.	5.98	4.97	10.95	6.76	9443.
2000.	6.24	5.06	11.30	6.82	10120.
2100.	6.48	5.15	11.63	6.88	10815.
2200.	6.73	5.23	11.96	6.94	11506.
2300.	6.97	5.30	12.27	7.00	12190.
273.15	0.349	0.832	1.181	2.376	227.3
298.15	0.428	0.974	1.402	2.650	290.4

Table 5. B(amorphous) (x is the zero-point entropy)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
0.	X	0.0	X	0.0	0.0
50.	0.016+X	0.015	0.031+X	0.041	0.7
100.	0.044	0.088	0.132	0.330	8.8
150.	0.107	0.252	0.359	0.860	37.8
200.	0.211	0.490	0.701	1.549	98.0
250.	0.350	0.769	1.119	2.218	192.2
300.	0.516	1.066	1.582	2.879	319.8
350.	0.70	1.36	2.06	3.39	476.
400.	0.90	1.64	2.54	3.78	656.
450.	1.11	1.90	3.01	4.11	855.
500.	1.33	2.13	3.46	4.40	1065.
600.	1.75	2.55	4.30	4.88	1530.
700.	2.17	2.91	5.08	5.26	2037.
800.	2.58	3.23	5.81	5.57	2584.
900.	2.98	3.50	6.48	5.83	3150.
1000.	3.37	3.74	7.11	6.05	3740.
1100.	3.73	3.96	7.69	6.24	4356.
1200.	4.08	4.16	8.24	6.39	4992.
1300.	4.42	4.34	8.76	6.53	5642.
1400.	4.85	4.50	9.35	6.65	6300.
1500.	5.16	4.65	9.81	6.75	6915.
1600.	5.47	4.78	10.25	6.83	7648.
1700.	5.77	4.90	10.67	6.90	8330.
1800.	6.05	5.01	11.06	6.96	9018.
1900.	6.32	5.12	11.44	7.02	9728.
2000.	6.59	5.21	11.80	7.07	10420.
2100.	6.85	5.30	12.15	7.11	11130.
2200.	7.09	5.39	12.48	7.15	11858.
2300.	7.33	5.47	12.80	7.19	12581.
273.15	0.424	0.905	1.329	2.523	247.2
298.15	0.510	1.054	1.564	2.858	314.3

Table 6. B(liquid)

T	$-\frac{(F°-H°_0)}{T}$	$\frac{(H°-H°_0)}{T}$	S°	$C°_p$	$(H°-H_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
2300.	6.97	7.50	14.47	7.3	17250.
2400.	7.27	7.49	14.76	7.3	17250.
2500.	7.58	7.48	15.06	7.3	18700.
2600.	7.86	7.48	15.34	7.3	19448.
2700.	8.15	7.47	15.62	7.3	20169.
2800.	8.42	7.46	15.88	7.3	20888.
2900.	8.68	7.46	16.14	7.3	21634.
3000.	8.94	7.45	16.39	7.3	22350.
3100.	9.18	7.45	16.63	7.3	23095.
3200.	9.42	7.44	16.86	7.3	23808.
3300.	9.64	7.44	17.08	7.3	24552.
3400.	9.86	7.44	17.30	7.3	25296.
3500.	10.08	7.43	17.51	7.3	26005.
3600.	10.29	7.43	17.72	7.3	26748.
3700.	10.50	7.42	17.92	7.3	27454.
3800.	10.70	7.42	18.12	7.3	28196.
3900.	10.89	7.42	18.31	7.3	28938.
4000.	11.08	7.41	18.49	7.3	29640.
4100.	11.26	7.41	18.67	7.3	30381.
4200.	11.44	7.41	18.85	7.3	31122.
4300.	11.61	7.41	19.02	7.3	31863.
4400.	11.79	7.40	19.19	7.3	32560.
4500.	11.95	7.40	19.35	7.3	33300.

Table 7. B(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	22.250	5.479	27.729	273.9	5.072
75.	24.441	5.331	29.772	399.8	5.013
100.	25.962	5.249	31.211	524.9	4.993
125.	27.127	5.197	32.324	649.6	4.984
150.	28.071	5.161	33.232	774.1	4.979
175.	28.865	5.135	34.000	898.6	4.976
200.	29.549	5.115	34.664	1022.9	4.974
225.	30.151	5.099	35.250	1147.3	4.973
250.	30.687	5.086	35.774	1271.6	4.972
275.	31.171	5.076	36.247	1395.9	4.971
300.	31.613	5.067	36.680	1520.2	4.971
325.	32.018	5.060	37.078	1644.4	4.970
350.	32.393	5.053	37.446	1768.7	4.970
375.	32.741	5.048	37.789	1892.9	4.970
400.	33.067	5.043	38.110	2017.2	4.970
425.	33.372	5.039	38.411	2141.4	4.969
450.	33.660	5.035	38.695	2265.6	4.969
475.	33.932	5.031	38.964	2389.9	4.969
500.	34.190	5.028	39.219	2514.1	4.969
550.	34.669	5.023	39.692	2762.6	4.969
600.	35.106	5.018	40.125	3011.0	4.969
650.	35.508	5.015	40.522	3259.4	4.969
700.	35.879	5.011	40.891	3507.9	4.969
750.	36.225	5.008	41.233	3756.3	4.969
800.	36.548	5.006	41.554	4004.7	4.969
850.	36.851	5.004	41.855	4253.1	4.968
900.	37.137	5.002	42.139	4501.6	4.968
950.	37.408	5.000	42.408	4750.0	4.968
1000.	37.664	4.998	42.663	4998.4	4.968
1050.	37.908	4.997	42.905	5246.8	4.968
1100.	38.140	4.996	43.136	5495.3	4.968
1150.	38.363	4.994	43.357	5743.7	4.968
1200.	38.575	4.993	43.568	5992.1	4.968
1250.	38.779	4.992	43.771	6240.5	4.968
1300.	38.975	4.991	43.966	6488.9	4.968
1350.	39.163	4.991	44.154	6737.3	4.968
1400.	39.345	4.990	44.334	6985.7	4.968
1450.	39.520	4.989	44.509	7234.2	4.968
1500.	39.689	4.988	44.677	7482.6	4.968
1550.	39.852	4.988	44.840	7731.0	4.968
1600.	40.011	4.987	44.998	7979.4	4.968
1650.	40.164	4.987	45.151	8227.8	4.968
1700.	40.313	4.986	45.299	8476.2	4.968
1750.	40.457	4.986	45.443	8724.6	4.968
1800.	40.598	4.985	45.583	8973.0	4.968
1850.	40.734	4.985	45.719	9221.4	4.968
1900.	40.867	4.984	45.852	9469.9	4.968
1950.	40.997	4.984	45.981	9718.3	4.968
2000.	41.123	4.983	46.106	9966.7	4.968
2050.	41.246	4.983	46.229	10215.1	4.968

Table 7. B(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	41.366	4.983	46.349	10463.5	4.968
2150.	41.483	4.982	46.466	10711.9	4.968
2200.	41.598	4.982	46.580	10960.3	4.968
2250.	41.710	4.982	46.692	11208.7	4.968
2300.	41.819	4.981	46.801	11457.1	4.968
2350.	41.927	4.981	46.908	11705.6	4.968
2400.	42.031	4.981	47.012	11954.0	4.968
2450.	42.134	4.981	47.115	12202.4	4.968
2500.	42.235	4.980	47.215	12450.8	4.968
2600.	42.430	4.980	47.410	12947.6	4.968
2700.	42.618	4.979	47.597	13444.5	4.968
2800.	42.799	4.979	47.778	13941.3	4.969
2900.	42.974	4.979	47.952	14438.2	4.969
3000.	43.143	4.978	48.121	14935.0	4.969
3100.	43.306	4.978	48.284	15431.9	4.969
3200.	43.464	4.978	48.442	15928.9	4.970
3300.	43.617	4.978	48.595	16425.9	4.970
3400.	43.766	4.977	48.743	16923.0	4.971
3500.	43.910	4.977	48.887	17420.1	4.972
3600.	44.050	4.977	49.027	17917.4	4.973
3700.	44.186	4.977	49.163	18414.9	4.975
3800.	44.319	4.977	49.296	18912.4	4.977
3900.	44.448	4.977	49.425	19410.2	4.979
4000.	44.574	4.977	49.552	19908.3	4.982
4100.	44.697	4.977	49.675	20406.6	4.985
4200.	44.817	4.977	49.795	20905.3	4.988
4300.	44.934	4.978	49.912	21404.3	4.993
4400.	45.049	4.978	50.027	21903.8	4.997
4500.	45.161	4.979	50.139	22403.8	5.002
4600.	45.270	4.979	50.249	22904.3	5.008
4700.	45.377	4.980	50.357	23405.5	5.015
4800.	45.482	4.981	50.463	23907.3	5.022
4900.	45.585	4.982	50.566	24409.9	5.030
5000.	45.685	4.983	50.668	24913.3	5.039
5100.	45.784	4.984	50.768	25417.6	5.048
5200.	45.881	4.985	50.866	25922.9	5.058
5300.	45.976	4.987	50.963	26429.3	5.069
5400.	46.069	4.988	51.057	26936.7	5.081
5500.	46.161	4.990	51.151	27445.4	5.093
5600.	46.251	4.992	51.243	27955.4	5.107
5700.	46.339	4.994	51.333	28466.8	5.121
5800.	46.426	4.996	51.422	28979.6	5.136
5900.	46.511	4.999	51.510	29494.0	5.152
6000.	46.595	5.002	51.597	30010.0	5.168
273.15	31.137	5.077	36.214	1386.7	4.971
298.15	31.581	5.068	36.649	1511.0	4.971

Table 8. B_2(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	28.793	6.933	35.726	346.6	6.957
75.	31.606	6.941	38.546	520.6	6.957
100.	33.603	6.945	40.548	694.5	6.958
125.	35.153	6.948	42.101	868.5	6.960
150.	36.420	6.950	43.370	1042.6	6.968
175.	37.492	6.954	44.446	1217.0	6.988
200.	38.421	6.960	45.381	1392.1	7.023
225.	39.241	6.970	46.211	1568.3	7.076
250.	39.976	6.984	46.960	1746.0	7.143
275.	40.643	7.002	47.644	1925.5	7.221
300.	41.253	7.024	48.276	2107.1	7.308
325.	41.816	7.049	48.865	2290.9	7.398
350.	42.339	7.077	49.417	2477.0	7.490
375.	42.829	7.108	49.936	2665.4	7.580
400.	43.288	7.140	50.428	2856.0	7.668
425.	43.722	7.174	50.896	3048.8	7.752
450.	44.133	7.208	51.341	3243.6	7.832
475.	44.524	7.243	51.767	3440.3	7.907
500.	44.896	7.278	52.174	3638.9	7.977
550.	45.593	7.347	52.940	4041.0	8.104
600.	46.235	7.415	53.650	4449.0	8.213
650.	46.831	7.480	54.312	4862.1	8.308
700.	47.388	7.542	54.930	5279.6	8.390
750.	47.910	7.601	55.512	5700.9	8.462
800.	48.403	7.657	56.060	6125.6	8.524
850.	48.869	7.710	56.578	6553.2	8.579
900.	49.311	7.759	57.070	6983.4	8.627
950.	49.732	7.806	57.538	7415.8	8.670
1000.	50.133	7.850	57.983	7850.3	8.708
1050.	50.517	7.892	58.409	8286.6	8.743
1100.	50.885	7.931	58.817	8724.5	8.774
1150.	51.239	7.969	59.207	9164.0	8.802
1200.	51.578	8.004	59.582	9604.7	8.828
1250.	51.906	8.037	59.943	10046.8	8.852
1300.	52.222	8.069	60.291	10489.9	8.874
1350.	52.527	8.099	60.626	10934.2	8.895
1400.	52.822	8.128	60.950	11379.4	8.914
1450.	53.108	8.156	61.263	11825.5	8.932
1500.	53.385	8.182	61.566	12272.6	8.949
1550.	53.653	8.207	61.860	12720.4	8.965
1600.	53.914	8.231	62.145	13169.0	8.980
1650.	54.168	8.254	62.421	13618.4	8.995
1700.	54.415	8.276	62.690	14068.5	9.008
1750.	54.655	8.297	62.951	14519.2	9.022
1800.	54.889	8.317	63.206	14970.6	9.034
1850.	55.117	8.337	63.453	15422.7	9.047
1900.	55.339	8.355	63.695	15875.3	9.059
1950.	55.557	8.374	63.930	16328.6	9.070
2000.	55.769	8.391	64.160	16782.4	9.082
2050.	55.976	8.408	64.385	17236.7	9.093

Table 8. B_2(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	56.179	8.425	64.604	17691.6	9.103
2150.	56.378	8.440	64.818	18147.0	9.114
2200.	56.572	8.456	65.028	18603.0	9.124
2250.	56.762	8.471	65.233	19059.4	9.134
2300.	56.948	8.485	65.434	19516.4	9.144
2350.	57.131	8.500	65.630	19973.8	9.154
2400.	57.310	8.513	65.823	20431.8	9.163
2450.	57.486	8.527	66.012	20890.2	9.173
2500.	57.658	8.540	66.198	21349.1	9.182
2600.	57.994	8.565	66.558	22268.2	9.201
2700.	58.317	8.589	66.906	23189.2	9.219
2800.	58.630	8.611	67.241	24112.0	9.237
2900.	58.933	8.633	67.566	25036.6	9.255
3000.	59.226	8.654	67.880	25962.9	9.272
3100.	59.510	8.675	68.184	26891.0	9.290
3200.	59.785	8.694	68.479	27820.9	9.307
3300.	60.053	8.713	68.766	28752.4	9.324
3400.	60.314	8.731	69.045	29685.7	9.342
3500.	60.567	8.749	69.316	30620.7	9.359
3600.	60.814	8.766	69.580	31557.5	9.376
3700.	61.054	8.783	69.837	32495.9	9.393
3800.	61.289	8.799	70.088	33436.1	9.411
3900.	61.517	8.815	70.332	34378.1	9.428
4000.	61.741	8.830	70.571	35321.7	9.445
4100.	61.959	8.846	70.805	36267.2	9.463
4200.	62.172	8.861	71.033	37214.3	9.480
4300.	62.381	8.875	71.256	38163.3	9.498
4400.	62.585	8.890	71.475	39113.9	9.516
4500.	62.785	8.904	71.689	40066.4	9.534
4600.	62.981	8.918	71.898	41020.7	9.552
4700.	63.173	8.931	72.104	41976.7	9.570
4800.	63.361	8.945	72.306	42934.6	9.588
4900.	63.546	8.958	72.504	43894.3	9.606
5000.	63.727	8.971	72.698	44855.8	9.624
5100.	63.904	8.984	72.889	45819.2	9.643
5200.	64.079	8.997	73.076	46784.4	9.661
5300.	64.251	9.010	73.260	47751.5	9.680
5400.	64.419	9.022	73.441	48720.4	9.699
5500.	64.585	9.035	73.619	49691.3	9.718
5600.	64.748	9.047	73.795	50664.0	9.737
5700.	64.908	9.059	73.967	51638.7	9.756
5800.	65.066	9.072	74.137	52615.3	9.776
5900.	65.221	9.084	74.304	53593.9	9.795
6000.	65.373	9.096	74.469	54574.4	9.815
273.15	40.595	7.000	47.596	1912.2	7.215
298.15	41.209	7.022	48.231	2093.6	7.301

Table 9. BO(gas)

T	$-(F^\circ-H^\circ_0)$	$(H^\circ-H^\circ_0)$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	27.885	6.921	34.807	346.1	6.956
75.	30.694	6.933	37.627	520.0	6.956
100.	32.689	6.939	39.628	693.9	6.957
125.	34.238	6.942	41.181	867.8	6.957
150.	35.504	6.945	42.449	1041.7	6.957
175.	36.575	6.947	43.521	1215.7	6.957
200.	37.503	6.948	44.451	1389.6	6.958
225.	38.321	6.949	45.270	1563.6	6.960
250.	39.053	6.950	46.004	1737.6	6.963
275.	39.716	6.952	46.668	1911.8	6.969
300.	40.321	6.954	47.274	2086.1	6.979
325.	40.877	6.956	47.833	2260.8	6.994
350.	41.393	6.960	48.352	2435.8	7.014
375.	41.873	6.964	48.837	2611.5	7.038
400.	42.323	6.970	49.292	2787.8	7.069
425.	42.746	6.976	49.722	2964.9	7.103
450.	43.145	6.984	50.129	3143.0	7.142
475.	43.522	6.994	50.516	3322.1	7.185
500.	43.881	7.005	50.886	3502.3	7.230
550.	44.550	7.029	51.580	3866.2	7.327
600.	45.163	7.058	52.222	4235.1	7.428
650.	45.729	7.091	52.820	4609.0	7.529
700.	46.256	7.126	53.382	4987.9	7.628
750.	46.749	7.162	53.911	5371.7	7.722
800.	47.212	7.200	54.412	5760.0	7.811
850.	47.650	7.238	54.888	6152.7	7.894
900.	48.065	7.277	55.342	6549.4	7.972
950.	48.459	7.316	55.775	6949.8	8.044
1000.	48.836	7.354	56.189	7353.6	8.110
1050.	49.195	7.391	56.586	7760.7	8.171
1100.	49.540	7.428	56.968	8170.6	8.227
1150.	49.871	7.464	57.335	8583.3	8.278
1200.	50.189	7.499	57.688	8998.4	8.326
1250.	50.496	7.533	58.029	9415.8	8.370
1300.	50.792	7.566	58.358	9835.3	8.410
1350.	51.078	7.598	58.676	10256.8	8.448
1400.	51.355	7.629	58.984	10680.1	8.482
1450.	51.623	7.659	59.282	11105.0	8.514
1500.	51.883	7.688	59.571	11531.5	8.544
1550.	52.136	7.716	59.852	11959.4	8.572
1600.	52.381	7.743	60.124	12388.6	8.598
1650.	52.620	7.769	60.389	12819.1	8.622
1700.	52.852	7.795	60.647	13250.8	8.644
1750.	53.079	7.819	60.898	13683.5	8.665
1800.	53.299	7.843	61.142	14117.3	8.685
1850.	53.515	7.866	61.380	14552.0	8.704
1900.	53.725	7.888	61.613	14987.7	8.721
1950.	53.930	7.910	61.840	15424.1	8.738
2000.	54.130	7.931	62.061	15861.4	8.753
2050.	54.326	7.951	62.277	16299.5	8.768

Table 9. BO(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	54.518	7.971	62.489	16738.2	8.782
2150.	54.706	7.990	62.696	17177.7	8.795
2200.	54.890	8.008	62.898	17617.8	8.808
2250.	55.070	8.026	63.096	18058.5	8.820
2300.	55.247	8.043	63.290	18499.8	8.832
2350.	55.420	8.060	63.480	18941.6	8.843
2400.	55.590	8.077	63.666	19384.0	8.853
2450.	55.756	8.093	63.849	19826.9	8.863
2500.	55.920	8.108	64.028	20270.3	8.873
2600.	56.239	8.138	64.376	21158.5	8.891
2700.	56.546	8.166	64.712	22048.4	8.908
2800.	56.844	8.193	65.037	22940.0	8.923
2900.	57.132	8.218	65.350	23833.1	8.938
3000.	57.411	8.243	65.653	24727.6	8.952
3100.	57.681	8.266	65.947	25623.4	8.965
3200.	57.944	8.288	66.232	26520.6	8.977
3300.	58.199	8.309	66.508	27418.9	8.989
3400.	58.448	8.329	66.777	28318.4	9.000
3500.	58.690	8.348	67.038	29219.0	9.011
3600.	58.925	8.367	67.292	30120.6	9.022
3700.	59.154	8.385	67.539	31023.3	9.032
3800.	59.378	8.402	67.780	31926.9	9.041
3900.	59.597	8.418	68.015	32831.5	9.051
4000.	59.810	8.434	68.244	33737.1	9.060
4100.	60.019	8.450	68.468	34643.5	9.069
4200.	60.222	8.464	68.687	35550.8	9.077
4300.	60.422	8.479	68.901	36458.9	9.086
4400.	60.617	8.493	69.109	37367.9	9.094
4500.	60.808	8.506	69.314	38277.7	9.102
4600.	60.995	8.519	69.514	39188.3	9.110
4700.	61.178	8.532	69.710	40099.7	9.118
4800.	61.358	8.544	69.902	41011.9	9.126
4900.	61.534	8.556	70.090	41924.9	9.133
5000.	61.707	8.568	70.275	42838.6	9.141
5100.	61.877	8.579	70.456	43753.0	9.148
5200.	62.044	8.590	70.634	44668.2	9.156
5300.	62.207	8.601	70.808	45584.1	9.163
5400.	62.368	8.611	70.980	46500.8	9.170
5500.	62.526	8.621	71.148	47418.1	9.177
5600.	62.682	8.631	71.313	48336.2	9.184
5700.	62.835	8.641	71.476	49255.0	9.191
5800.	62.985	8.651	71.636	50174.5	9.198
5900.	63.133	8.660	71.793	51094.7	9.205
6000.	63.279	8.669	71.948	52015.6	9.212
273.15	39.669	6.952	46.620	1898.9	6.969
298.15	40.278	6.954	47.231	2073.2	6.978

Table 10. B_2O_2(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	33.921	6.959	40.881	348.0	7.008
75.	36.753	7.027	43.780	527.0	7.380
100.	38.795	7.193	45.988	719.3	8.028
125.	40.425	7.434	47.858	929.2	8.771
150.	41.805	7.720	49.525	1158.0	9.532
175.	43.018	8.032	51.050	1405.6	10.273
200.	44.112	8.356	52.468	1671.3	10.970
225.	45.115	8.683	53.798	1953.7	11.611
250.	46.046	9.005	55.051	2251.3	12.188
275.	46.919	9.318	56.238	2562.6	12.705
300.	47.743	9.620	57.363	2886.0	13.165
325.	48.525	9.909	58.434	3220.4	13.578
350.	49.269	10.185	59.454	3564.6	13.950
375.	49.981	10.447	60.428	3917.7	14.289
400.	50.663	10.697	61.360	4278.8	14.600
425.	51.319	10.935	62.254	4647.5	14.888
450.	51.950	11.162	63.113	5023.0	15.156
475.	52.560	11.379	63.939	5405.1	15.408
500.	53.149	11.587	64.735	5793.3	15.645
550.	54.272	11.976	66.247	6586.7	16.083
600.	55.329	12.335	67.664	7400.9	16.478
650.	56.330	12.668	68.997	8233.9	16.836
700.	57.280	12.977	70.257	9084.0	17.161
750.	58.185	13.266	71.451	9949.5	17.456
800.	59.050	13.536	72.587	10829.1	17.722
850.	59.879	13.790	73.668	11721.3	17.964
900.	60.674	14.028	74.701	12625.1	18.183
950.	61.438	14.252	75.690	13539.3	18.381
1000.	62.174	14.463	76.637	14462.9	18.560
1050.	62.885	14.662	77.547	15395.1	18.723
1100.	63.571	14.850	78.421	16335.0	18.871
1150.	64.236	15.028	79.263	17281.9	19.005
1200.	64.879	15.196	80.075	18235.3	19.128
1250.	65.502	15.356	80.858	19194.5	19.239
1300.	66.108	15.507	81.615	20159.1	19.341
1350.	66.695	15.651	82.346	21128.5	19.434
1400.	67.267	15.787	83.055	22102.4	19.520
1450.	67.823	15.918	83.741	23080.4	19.598
1500.	68.365	16.041	84.407	24062.1	19.670
1550.	68.893	16.160	85.053	25047.3	19.737
1600.	69.408	16.272	85.680	26035.7	19.798
1650.	69.910	16.380	86.290	27027.1	19.855
1700.	70.401	16.483	86.884	28021.1	19.907
1750.	70.880	16.582	87.462	29017.7	19.956
1800.	71.349	16.676	88.024	30016.6	20.001
1850.	71.807	16.766	88.573	31017.7	20.043
1900.	72.255	16.853	89.108	32020.9	20.082
1950.	72.694	16.936	89.630	33025.9	20.118
2000.	73.124	17.016	90.140	34032.7	20.152
2050.	73.545	17.093	90.638	35041.1	20.184

Table 10. B_2O_2(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	73.958	17.167	91.125	36051.0	20.214
2150.	74.362	17.238	91.601	37062.4	20.242
2200.	74.759	17.307	92.066	38075.2	20.268
2250.	75.149	17.373	92.522	39089.2	20.293
2300.	75.532	17.437	92.968	40104.4	20.316
2350.	75.907	17.498	93.406	41120.8	20.338
2400.	76.276	17.558	93.834	42138.2	20.358
2450.	76.639	17.615	94.254	43156.6	20.378
2500.	76.995	17.670	94.666	44175.9	20.396
2600.	77.691	17.776	95.466	46217.3	20.430
2700.	78.363	17.875	96.238	48261.8	20.460
2800.	79.015	17.968	96.983	50309.2	20.487
2900.	79.647	18.055	97.702	52359.2	20.512
3000.	80.261	18.137	98.398	54411.6	20.535
3100.	80.857	18.215	99.071	56466.0	20.555
3200.	81.436	18.288	99.724	58522.5	20.573
3300.	82.000	18.358	100.358	60580.7	20.590
3400.	82.549	18.424	100.973	62640.5	20.606
3500.	83.084	18.486	101.570	64701.8	20.620
3600.	83.605	18.546	102.151	66764.5	20.633
3700.	84.114	18.602	102.717	68828.4	20.645
3800.	84.611	18.656	103.267	70893.5	20.657
3900.	85.096	18.708	103.804	72959.7	20.667
4000.	85.571	18.757	104.327	75026.9	20.677
4100.	86.034	18.804	104.838	77095.0	20.686
4200.	86.488	18.849	105.337	79164.0	20.694
4300.	86.932	18.892	105.824	81233.8	20.702
4400.	87.367	18.933	106.300	83304.3	20.709
4500.	87.793	18.972	106.765	85375.6	20.716
4600.	88.210	19.010	107.221	87447.5	20.722
4700.	88.619	19.047	107.666	89520.0	20.728
4800.	89.021	19.082	108.103	91593.1	20.734
4900.	89.415	19.116	108.530	93666.7	20.739
5000.	89.801	19.148	108.949	95740.9	20.744
5100.	90.181	19.180	109.360	97815.5	20.749
5200.	90.553	19.210	109.763	99890.6	20.753
5300.	90.920	19.239	110.158	101966.1	20.757
5400.	91.279	19.267	110.547	104042.1	20.761
5500.	91.633	19.294	110.928	106118.4	20.765
5600.	91.981	19.321	111.302	108195.0	20.769
5700.	92.323	19.346	111.669	110272.1	20.772
5800.	92.660	19.371	112.031	112349.4	20.775
5900.	92.991	19.394	112.386	114427.1	20.778
6000.	93.318	19.418	112.735	116505.0	20.781
273.15	46.856	9.296	56.152	2539.1	12.668
298.15	47.684	9.598	57.282	2861.7	13.133
0.					

Table 11. B_2O_3(crystal)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
0.	0.0	0.0	0.0	0.0	0.0
50.	0.132	0.380	0.512	1.45	19.0
100.	0.809	1.817	2.626	4.99	181.7
150.	1.844	3.379	5.223	7.93	506.8
200.	3.019	4.842	7.861	10.48	968.2
250.	4.247	6.208	10.455	12.85	1552.0
300.	5.495	7.503	12.998	15.12	2250.9
350.	6.75	8.76	15.51	17.0	3066.
400.	7.99	9.89	17.88	18.6	3956.
450.	9.22	10.93	20.15	19.9	4918.
500.	10.42	11.82	22.24	21.0	5912.
600.	12.71	13.43	26.14	23.2	8058.
700.	14.91	15.14	30.05	28.4	10598.
723.	15.39	15.59	30.98	30.2	11272.
273.15	4.825	6.315	11.640	13.89	1861.6
298.15	5.449	7.456	12.905	15.04	2223.1

Table 12. B_2O_3(amorphous, glass)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
298.15	-3.55	22.10	18.55	14.6	6589.
300.	-3.39	22.05	18.66	14.7	6615.
350.	-0.08	21.09	21.01	16.3	7382.
400.	2.70	20.60	23.30	17.9	8240.
450.	5.11	20.36	25.47	19.1	9162.
500.	7.26	20.33	27.59	21.7	10165.
600.	11.10	22.05	33.15	32.2	13230.
700.	14.62	23.49	38.11	32.1	16443.
723.	15.39	23.76	39.15	32.0	17178.

Based on B_2O_3(c) at 0°K

Table 13. B_2O_3(liquid)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
723.	15.39	23.76	39.15	32.0	17178.
800.	17.84	24.55	42.39	31.8	19640.
900.	20.77	25.34	46.11	31.3	22806.
1000.	23.47	25.91	49.38	30.8	25910.
1100.	25.95	26.34	52.29	30.6	28974.
1200.	28.25	26.69	54.94	30.4	32028.
1300.	30.41	26.97	57.38	30.2	35061.
1400.	32.42	27.20	59.62	30.0	38080.
1500.	34.31	27.39	61.70	30.1	41085.
1600.	36.08	27.57	63.65	30.4	44112.
1700.	37.74	27.75	65.49	30.6	47173.
1800.	39.33	27.91	67.24	30.8	50238.
1900.	40.84	28.07	68.91	31.0	53333.
2000.	42.28	28.22	70.50	31.1	56440.
2100.	43.66	28.36	72.02	31.2	59556.
2200.	44.98	28.49	73.47	31.3	62678.
2300.	46.25	28.61	74.86	31.4	65803.
2400.	47.47	28.73	76.20	31.5	68952.
2500.	48.65	28.84	77.49	31.6	72100.
2600.	49.78	28.95	78.73	31.6	75270.
2700.	50.87	29.05	79.92	31.7	78435.
2800.	51.93	29.14	81.07	31.7	81592.
2900.	52.95	29.23	82.18	31.8	84767.
3000.	53.94	29.32	83.26	31.8	87960.
3100.	54.90	29.40	84.30	31.8	91140.
3200.	55.83	29.48	85.31	31.9	94336.
3300.	56.74	29.55	86.29	31.9	97515.
3400.	57.62	29.62	87.24	31.9	100708.
3500.	58.48	29.68	88.16	31.9	103880.
3600.	59.32	29.74	89.06	32.0	107064.
3700.	60.14	29.80	89.94	32.0	110260.
3800.	60.93	29.86	90.79	32.0	113468.
3900.	61.71	29.91	91.62	32.0	116649.
4000.	62.46	29.97	92.43	32.1	119880.

Table 14. B_2O_3 (gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	40.119	7.949	48.068	397.5	7.970
75.	43.346	7.979	51.325	598.4	8.134
100.	45.651	8.053	53.703	805.3	8.428
125.	47.459	8.162	55.620	1020.2	8.773
150.	48.958	8.295	57.254	1244.3	9.162
175.	50.248	8.450	58.699	1478.8	9.610
200.	51.388	8.626	60.014	1725.3	10.117
225.	52.415	8.822	61.238	1985.0	10.669
250.	53.356	9.036	62.392	2259.0	11.251
275.	54.227	9.264	63.492	2547.7	11.845
300.	55.044	9.504	64.548	2851.2	12.439
325.	55.814	9.752	65.567	3169.5	13.024
350.	56.546	10.007	66.553	3502.3	13.594
375.	57.245	10.264	67.510	3849.1	14.146
400.	57.916	10.524	68.440	4209.4	14.677
425.	58.562	10.783	69.345	4582.7	15.187
450.	59.186	11.041	70.227	4968.6	15.675
475.	59.789	11.297	71.087	5366.3	16.140
500.	60.375	11.551	71.926	5775.4	16.584
550.	61.500	12.046	73.546	6625.5	17.408
600.	62.568	12.525	75.093	7514.9	18.152
650.	63.589	12.984	76.573	8439.5	18.821
700.	64.568	13.423	77.990	9395.9	19.422
750.	65.508	13.841	79.349	10380.7	19.961
800.	66.414	14.239	80.653	11391.1	20.445
850.	67.289	14.617	81.906	12424.4	20.879
900.	68.135	14.976	83.110	13478.2	21.269
950.	68.953	15.316	84.270	14550.6	21.619
1000.	69.747	15.640	85.387	15639.5	21.934
1050.	70.518	15.946	86.464	16743.5	22.218
1100.	71.266	16.237	87.504	17860.9	22.475
1150.	71.994	16.514	88.508	18990.6	22.707
1200.	72.703	16.776	89.479	20131.3	22.918
1250.	73.393	17.026	90.418	21282.0	23.109
1300.	74.065	17.263	91.328	22441.9	23.283
1350.	74.721	17.489	92.210	23610.1	23.442
1400.	75.361	17.704	93.065	24785.9	23.587
1450.	75.986	17.909	93.895	25968.6	23.720
1500.	76.596	18.105	94.701	27157.7	23.842
1550.	77.193	18.292	95.485	28352.7	23.954
1600.	77.777	18.471	96.247	29553.0	24.058
1650.	78.348	18.641	96.989	30758.3	24.153
1700.	78.907	18.805	97.711	31968.2	24.241
1750.	79.454	18.961	98.415	33182.3	24.323
1800.	79.990	19.111	99.102	34400.4	24.399
1850.	80.516	19.255	99.771	35622.1	24.469
1900.	81.031	19.393	100.424	36847.2	24.534
1950.	81.537	19.526	101.062	38075.4	24.595
2000.	82.033	19.653	101.686	39306.6	24.652
2050.	82.519	19.776	102.295	40540.6	24.705

Table 14. B_2O_3 (gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	82.997	19.894	102.891	41777.1	24.755
2150.	83.467	20.007	103.474	43016.0	24.801
2200.	83.928	20.117	104.045	44257.2	24.845
2250.	84.381	20.222	104.604	45500.5	24.886
2300.	84.827	20.324	105.151	46745.7	24.925
2350.	85.265	20.423	105.688	47992.9	24.961
2400.	85.696	20.517	106.213	49241.8	24.995
2450.	86.120	20.609	106.729	50492.4	25.027
2500.	86.537	20.698	107.235	51744.5	25.058
2600.	87.352	20.867	108.219	54253.1	25.114
2700.	88.143	21.025	109.168	56767.1	25.164
2800.	88.910	21.174	110.084	59285.8	25.209
2900.	89.656	21.313	110.969	61808.8	25.250
3000.	90.381	21.445	111.826	64335.7	25.287
3100.	91.086	21.570	112.655	66866.2	25.321
3200.	91.772	21.687	113.460	69399.8	25.352
3300.	92.442	21.799	114.240	71936.4	25.380
3400.	93.094	21.905	114.998	74475.7	25.405
3500.	93.730	22.005	115.735	77017.4	25.429
3600.	94.352	22.100	116.452	79561.4	25.451
3700.	94.958	22.191	117.150	82107.5	25.471
3800.	95.551	22.278	117.829	84655.5	25.489
3900.	96.131	22.360	118.491	87205.3	25.506
4000.	96.698	22.439	119.137	89756.7	25.522
4100.	97.253	22.515	119.768	92309.7	25.537
4200.	97.797	22.587	120.383	94864.1	25.551
4300.	98.329	22.656	120.985	97419.8	25.564
4400.	98.850	22.722	121.572	99976.7	25.576
4500.	99.362	22.786	122.147	102534.9	25.587
4600.	99.863	22.847	122.710	105094.1	25.597
4700.	100.355	22.905	123.260	107654.3	25.607
4800.	100.838	22.962	123.800	110215.5	25.616
4900.	101.312	23.016	124.328	112777.5	25.625
5000.	101.778	23.068	124.846	115340.5	25.633
5100.	102.235	23.118	125.353	117904.2	25.641
5200.	102.684	23.167	125.851	120468.6	25.648
5300.	103.126	23.214	126.340	123033.8	25.655
5400.	103.560	23.259	126.820	125599.6	25.662
5500.	103.988	23.303	127.291	128166.1	25.668
5600.	104.408	23.345	127.753	130733.2	25.674
5700.	104.821	23.386	128.208	133300.8	25.679
5800.	105.228	23.426	128.654	135869.0	25.684
5900.	105.629	23.464	129.093	138437.7	25.689
6000.	106.024	23.501	129.525	141006.9	25.694
273.15	54.165	9.247	63.412	2525.8	11.801
298.15	54.985	9.486	64.471	2828.3	12.395
723.00	65.005	13.618	78.622	9845.5	19.678

Table 15. BH(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	21.888	6.726	28.614	336.3	6.963
75.	24.632	6.805	31.437	510.4	6.961
100.	26.596	6.844	33.440	684.4	6.961
125.	28.126	6.867	34.993	858.4	6.962
150.	29.379	6.883	36.262	1032.5	6.963
175.	30.441	6.895	37.336	1206.6	6.964
200.	31.362	6.903	38.266	1380.7	6.965
225.	32.176	6.910	39.086	1554.8	6.967
250.	32.904	6.916	39.820	1729.0	6.968
275.	33.564	6.921	40.485	1903.3	6.971
300.	34.166	6.925	41.091	2077.6	6.974
325.	34.721	6.929	41.650	2252.0	6.980
350.	35.234	6.933	42.167	2426.6	6.988
375.	35.713	6.937	42.650	2601.4	6.999
400.	36.161	6.941	43.102	2776.6	7.014
425.	36.581	6.946	43.528	2952.1	7.032
450.	36.979	6.952	43.930	3128.2	7.053
475.	37.355	6.958	44.312	3304.8	7.079
500.	37.712	6.964	44.676	3482.2	7.108
550.	38.376	6.980	45.357	3839.2	7.175
600.	38.984	7.000	45.984	4199.8	7.251
650.	39.546	7.022	46.568	4564.4	7.335
700.	40.067	7.048	47.114	4933.3	7.422
750.	40.554	7.075	47.629	5306.6	7.511
800.	41.012	7.105	48.117	5684.4	7.599
850.	41.443	7.137	48.580	6066.5	7.686
900.	41.852	7.170	49.022	6452.9	7.770
950.	42.241	7.204	49.444	6843.5	7.851
1000.	42.611	7.238	49.849	7238.0	7.929
1050.	42.965	7.273	50.238	7636.3	8.002
1100.	43.304	7.307	50.612	8038.2	8.072
1150.	43.630	7.342	50.972	8443.4	8.138
1200.	43.943	7.377	51.320	8851.9	8.200
1250.	44.245	7.411	51.655	9263.3	8.258
1300.	44.536	7.444	51.980	9677.6	8.314
1350.	44.818	7.478	52.295	10094.6	8.366
1400.	45.090	7.510	52.600	10514.2	8.415
1450.	45.354	7.542	52.896	10936.1	8.461
1500.	45.611	7.574	53.184	11360.3	8.505
1550.	45.859	7.604	53.464	11786.6	8.547
1600.	46.101	7.634	53.736	12214.9	8.587
1650.	46.337	7.664	54.000	12645.2	8.624
1700.	46.566	7.693	54.258	13077.3	8.660
1750.	46.789	7.721	54.510	13511.2	8.694
1800.	47.007	7.748	54.755	13946.7	8.726
1850.	47.220	7.775	54.995	14383.8	8.757
1900.	47.428	7.801	55.229	14822.4	8.787
1950.	47.630	7.827	55.457	15262.4	8.815
2000.	47.829	7.852	55.681	15703.9	8.843
2050.	48.023	7.876	55.900	16146.7	8.869

Table 15. BH(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	48.213	7.900	56.114	16590.8	8.894
2150.	48.399	7.924	56.323	17036.1	8.919
2200.	48.582	7.947	56.528	17482.6	8.942
2250.	48.761	7.969	56.730	17930.3	8.965
2300.	48.936	7.991	56.927	18379.1	8.987
2350.	49.108	8.012	57.121	18829.0	9.009
2400.	49.277	8.033	57.310	19280.0	9.030
2450.	49.443	8.054	57.497	19731.9	9.050
2500.	49.606	8.074	57.680	20184.9	9.070
2600.	49.923	8.113	58.036	21093.8	9.108
2700.	50.230	8.151	58.381	22006.4	9.144
2800.	50.527	8.187	58.714	22922.6	9.179
2900.	50.815	8.221	59.037	23842.3	9.213
3000.	51.094	8.255	59.350	24765.3	9.246
3100.	51.366	8.288	59.653	25691.5	9.278
3200.	51.629	8.319	59.948	26620.8	9.309
3300.	51.886	8.349	60.235	27553.3	9.340
3400.	52.135	8.379	60.514	28488.7	9.369
3500.	52.379	8.408	60.786	29427.1	9.399
3600.	52.616	8.436	61.052	30368.5	9.428
3700.	52.847	8.463	61.310	31312.7	9.456
3800.	53.074	8.489	61.563	32259.7	9.484
3900.	53.294	8.515	61.810	33209.5	9.512
4000.	53.510	8.541	62.051	34162.1	9.540
4100.	53.721	8.565	62.287	35117.5	9.567
4200.	53.928	8.589	62.518	36075.6	9.595
4300.	54.131	8.613	62.744	37036.4	9.622
4400.	54.329	8.636	62.965	38000.0	9.649
4500.	54.523	8.659	63.182	38966.3	9.676
4600.	54.714	8.682	63.395	39935.3	9.704
4700.	54.901	8.704	63.604	40907.0	9.731
4800.	55.084	8.725	63.809	41881.4	9.758
4900.	55.264	8.747	64.011	42858.5	9.785
5000.	55.441	8.768	64.209	43838.4	9.812
5100.	55.615	8.788	64.403	44820.9	9.839
5200.	55.786	8.809	64.595	45806.2	9.866
5300.	55.954	8.829	64.783	46794.2	9.894
5400.	56.119	8.849	64.968	47784.9	9.921
5500.	56.282	8.869	65.150	48778.3	9.948
5600.	56.442	8.888	65.330	49774.6	9.976
5700.	56.599	8.908	65.507	50773.5	10.004
5800.	56.754	8.927	65.681	51775.3	10.031
5900.	56.907	8.946	65.853	52779.8	10.059
6000.	57.057	8.965	66.022	53787.1	10.087
273.15	33.517	6.921	40.438	1890.4	6.970
298.15	34.123	6.925	41.048	2064.7	6.974

Table 16. BH_3(gas)

T	$-(F^\circ-H^\circ_0)$	$(H^\circ-H^\circ_0)$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	22.604	7.868	30.472	393.4	7.951
75.	25.801	7.895	33.696	592.2	7.950
100.	28.074	7.909	35.983	790.9	7.952
125.	29.840	7.919	37.759	989.9	7.966
150.	31.285	7.929	39.214	1189.4	8.003
175.	32.508	7.944	40.452	1390.2	8.068
200.	33.570	7.965	41.535	1593.0	8.159
225.	34.510	7.993	42.502	1798.4	8.269
250.	35.354	8.026	43.380	2006.6	8.393
275.	36.120	8.066	44.186	2218.1	8.527
300.	36.824	8.110	44.934	2433.0	8.668
325.	37.475	8.159	45.634	2651.6	8.817
350.	38.082	8.211	46.293	2873.9	8.973
375.	38.650	8.267	46.917	3100.3	9.135
400.	39.185	8.327	47.512	3330.7	9.305
425.	39.692	8.390	48.082	3565.6	9.482
450.	40.174	8.455	48.629	3804.9	9.665
475.	40.633	8.524	49.156	4048.9	9.854
500.	41.072	8.595	49.667	4297.7	10.049
550.	41.898	8.746	50.643	4810.1	10.451
600.	42.665	8.905	51.570	5342.9	10.864
650.	43.385	9.072	52.456	5896.6	11.283
700.	44.063	9.245	53.308	6471.2	11.700
750.	44.707	9.422	54.129	7066.5	12.111
800.	45.321	9.603	54.924	7682.1	12.511
850.	45.909	9.785	55.694	8317.4	12.898
900.	46.473	9.968	56.442	8971.6	13.269
950.	47.017	10.152	57.169	9644.0	13.623
1000.	47.542	10.334	57.876	10333.6	13.959
1050.	48.051	10.514	58.565	11039.6	14.277
1100.	48.544	10.692	59.236	11761.0	14.576
1150.	49.023	10.867	59.890	12496.9	14.858
1200.	49.489	11.039	60.528	13246.5	15.123
1250.	49.943	11.207	61.151	14009.0	15.371
1300.	50.386	11.372	61.758	14783.4	15.604
1350.	50.818	11.533	62.351	15569.1	15.822
1400.	51.241	11.690	62.930	16365.4	16.027
1450.	51.654	11.842	63.496	17171.6	16.218
1500.	52.058	11.991	64.049	17987.0	16.397
1550.	52.453	12.136	64.589	18811.1	16.565
1600.	52.841	12.277	65.118	19643.3	16.722
1650.	53.221	12.414	65.635	20483.1	16.869
1700.	53.593	12.547	66.140	21330.0	17.007
1750.	53.959	12.676	66.635	22183.7	17.137
1800.	54.318	12.802	67.120	23043.6	17.259
1850.	54.670	12.924	67.594	23909.4	17.373
1900.	55.016	13.043	68.059	24780.8	17.481
1950.	55.357	13.158	68.514	25657.4	17.582
2000.	55.691	13.269	68.961	26538.9	17.678
2050.	56.020	13.378	69.398	27425.1	17.768

Table 16. BH_3(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	56.344	13.484	69.827	28315.6	17.852
2150.	56.662	13.586	70.248	29210.3	17.933
2200.	56.976	13.686	70.662	30108.8	18.008
2250.	57.284	13.783	71.067	31011.0	18.080
2300.	57.588	13.877	71.465	31916.7	18.147
2350.	57.888	13.968	71.856	32825.7	18.212
2400.	58.183	14.057	72.240	33737.8	18.272
2450.	58.474	14.144	72.618	34652.9	18.330
2500.	58.760	14.228	72.988	35570.7	18.385
2600.	59.321	14.390	73.712	37414.4	18.486
2700.	59.867	14.544	74.411	39267.6	18.578
2800.	60.399	14.689	75.088	41129.6	18.661
2900.	60.917	14.827	75.744	42999.5	18.736
3000.	61.422	14.959	76.381	44876.6	18.805
3100.	61.914	15.084	76.998	46760.4	18.868
3200.	62.395	15.203	77.598	48650.1	18.926
3300.	62.865	15.317	78.181	50545.4	18.979
3400.	63.324	15.425	78.749	52445.7	19.028
3500.	63.772	15.529	79.301	54350.8	19.073
3600.	64.211	15.628	79.839	56260.2	19.114
3700.	64.641	15.723	80.363	58173.5	19.153
3800.	65.061	15.813	80.874	60090.6	19.188
3900.	65.473	15.900	81.373	62011.1	19.221
4000.	65.877	15.984	81.860	63934.7	19.252
4100.	66.272	16.064	82.336	65861.4	19.281
4200.	66.660	16.141	82.801	67790.8	19.307
4300.	67.041	16.215	83.256	69722.8	19.332
4400.	67.415	16.286	83.700	71657.2	19.356
4500.	67.781	16.354	84.135	73593.9	19.378
4600.	68.141	16.420	84.562	75532.8	19.398
4700.	68.495	16.484	84.979	77473.6	19.418
4800.	68.843	16.545	85.388	79416.3	19.436
4900.	69.185	16.604	85.789	81360.7	19.453
5000.	69.521	16.661	86.182	83306.8	19.469
5100.	69.851	16.717	86.568	85254.5	19.484
5200.	70.176	16.770	86.946	87203.7	19.499
5300.	70.496	16.822	87.318	89154.2	19.512
5400.	70.811	16.872	87.683	91106.1	19.525
5500.	71.121	16.920	88.041	93059.3	19.538
5600.	71.426	16.967	88.393	95013.6	19.549
5700.	71.727	17.012	88.739	96969.1	19.560
5800.	72.023	17.056	89.080	98925.6	19.571
5900.	72.315	17.099	89.414	100883.2	19.581
6000.	72.603	17.140	89.743	102841.7	19.590
273.15	36.066	8.063	44.129	2202.3	8.516
298.15	36.774	8.107	44.880	2417.0	8.658

Table 17. B_2H_6 (gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	31.105	7.939	39.044	397.0	7.955
75.	34.326	7.954	42.280	596.5	8.033
100.	36.619	7.997	44.616	799.7	8.235
125.	38.411	8.072	46.483	1009.0	8.525
150.	39.892	8.177	48.069	1226.6	8.898
175.	41.162	8.313	49.475	1454.8	9.379
200.	42.283	8.483	50.766	1696.6	9.986
225.	43.294	8.689	51.983	1955.1	10.713
250.	44.221	8.932	53.154	2233.1	11.539
275.	45.085	9.210	54.295	2532.6	12.435
300.	45.900	9.517	55.417	2855.2	13.376
325.	46.675	9.851	56.526	3201.6	14.338
350.	47.418	10.206	57.624	3572.1	15.305
375.	48.134	10.578	58.712	3966.8	16.264
400.	48.829	10.963	59.792	4385.2	17.207
425.	49.506	11.358	60.863	4827.0	18.130
450.	50.166	11.759	61.925	5291.5	19.028
475.	50.813	12.165	62.977	5778.2	19.901
500.	51.447	12.573	64.020	6286.3	20.746
550.	52.684	13.390	66.073	7364.3	22.354
600.	53.884	14.200	68.083	8519.9	23.854
650.	55.052	14.997	70.048	9747.9	25.247
700.	56.192	15.776	71.967	11042.9	26.538
750.	57.306	16.533	73.840	12400.1	27.732
800.	58.397	17.268	75.665	13814.6	28.834
850.	59.465	17.979	77.444	15282.0	29.849
900.	60.512	18.665	79.177	16798.1	30.783
950.	61.539	19.325	80.864	18359.0	31.641
1000.	62.547	19.961	82.508	19961.1	32.431
1050.	63.536	20.572	84.108	21601.0	33.156
1100.	64.506	21.160	85.666	23275.7	33.823
1150.	65.459	21.724	87.183	24982.4	34.436
1200.	66.395	22.265	88.661	26718.5	35.000
1250.	67.315	22.785	90.100	28481.7	35.520
1300.	68.218	23.284	91.503	30269.8	35.999
1350.	69.106	23.764	92.870	32080.9	36.440
1400.	69.979	24.224	94.203	33913.3	36.848
1450.	70.837	24.666	95.502	35765.3	37.226
1500.	71.680	25.090	96.770	37635.4	37.575
1550.	72.509	25.498	98.008	39522.3	37.898
1600.	73.325	25.891	99.216	41424.8	38.199
1650.	74.128	26.268	100.395	43341.8	38.478
1700.	74.917	26.631	101.548	45272.3	38.737
1750.	75.694	26.980	102.674	47215.3	38.979
1800.	76.459	27.317	103.776	49169.9	39.205
1850.	77.212	27.641	104.853	51135.5	39.415
1900.	77.953	27.953	105.907	53111.2	39.612
1950.	78.683	28.255	106.938	55096.5	39.796
2000.	79.402	28.545	107.948	57090.6	39.968
2050.	80.111	28.826	108.937	59093.1	40.130

Table 17. B_2H_6 (gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	80.809	29.097	109.905	61103.5	40.282
2150.	81.496	29.359	110.855	63121.2	40.425
2200.	82.174	29.612	111.786	65145.8	40.559
2250.	82.842	29.856	112.699	67177.0	40.686
2300.	83.501	30.093	113.594	69214.3	40.805
2350.	84.151	30.322	114.473	71257.4	40.918
2400.	84.792	30.544	115.336	73306.0	41.025
2450.	85.424	30.759	116.183	75359.8	41.125
2500.	86.047	30.967	117.015	77418.5	41.220
2600.	87.270	31.365	118.635	81549.5	41.396
2700.	88.460	31.740	120.200	85697.1	41.555
2800.	89.621	32.093	121.714	89859.9	41.697
2900.	90.753	32.426	123.179	94036.2	41.827
3000.	91.858	32.742	124.599	98224.9	41.945
3100.	92.936	33.040	125.977	102424.8	42.052
3200.	93.990	33.323	127.313	106634.9	42.150
3300.	95.019	33.592	128.612	110854.5	42.239
3400.	96.026	33.848	129.874	115082.6	42.322
3500.	97.011	34.091	131.102	119318.6	42.397
3600.	97.974	34.323	132.297	123561.9	42.467
3700.	98.918	34.544	133.462	127811.9	42.532
3800.	99.842	34.755	134.597	132068.1	42.591
3900.	100.747	34.956	135.704	136330.0	42.647
4000.	101.635	35.149	136.784	140597.3	42.698
4100.	102.505	35.334	137.839	144869.5	42.746
4200.	103.359	35.511	138.870	149146.4	42.791
4300.	104.196	35.681	139.877	153427.5	42.832
4400.	105.018	35.844	140.862	157712.7	42.871
4500.	105.826	36.000	141.826	162001.7	42.908
4600.	106.619	36.151	142.769	166294.2	42.942
4700.	107.398	36.296	143.693	170589.9	42.974
4800.	108.163	36.435	144.598	174888.8	43.004
4900.	108.916	36.570	145.485	179190.7	43.032
5000.	109.656	36.699	146.355	183495.2	43.059
5100.	110.384	36.824	147.208	187802.4	43.084
5200.	111.100	36.945	148.045	192112.0	43.108
5300.	111.805	37.061	148.866	196423.9	43.130
5400.	112.499	37.174	149.672	200738.0	43.152
5500.	113.182	37.283	150.464	205054.2	43.172
5600.	113.855	37.388	151.243	209372.3	43.191
5700.	114.517	37.490	152.007	213692.3	43.209
5800.	115.170	37.589	152.759	218014.1	43.226
5900.	115.814	37.684	153.498	222337.5	43.243
6000.	116.448	37.777	154.225	226662.6	43.258
273.15	45.023	9.188	54.211	2509.7	12.367
298.15	45.841	9.494	55.335	2830.5	13.305
180.32	41.412	8.346	49.758	1505.0	9.497

Table 18. B_5H_9(crystal)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
0.	0.0	0.0	0.0	0.0	0.0
50.	1.747	3.315	5.062	7.62	165.8
100.	5.172	6.646	11.818	11.93	664.6
150.	8.593	11.807	20.400	15.36	1771.0
200.	12.186	13.395	25.581	21.83	2679.0
226.34	13.919	14.728	28.647	28.11	3333.5

Table 19. B_5H_9(liquid)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
226.34	13.919	21.214	35.133	29.08	4801.6
250.	16.070	22.068	38.138	31.33	5517.0
300.	20.261	23.995	44.256	36.35	7198.5
273.15	17.696	23.303	40.999	33.33	6365.2
298.15	20.114	23.919	44.033	36.12	7131.4

Table 20. B_5H_9(gas)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	38.148	7.946	46.094	397.3	7.950
75.	41.371	7.952	49.322	596.4	7.996
100.	43.662	7.992	51.654	799.2	8.289
125.	45.457	8.117	53.574	1014.6	9.030
150.	46.957	8.365	55.322	1254.8	10.258
175.	48.273	8.748	57.021	1530.9	11.891
200.	49.473	9.259	58.732	1851.7	13.811
225.	50.599	9.880	60.479	2222.9	15.911
250.	51.676	10.592	62.268	2648.1	18.110
275.	52.722	11.377	64.099	3128.8	20.349
300.	53.747	12.218	65.966	3665.5	22.589
325.	54.760	13.101	67.862	4258.0	24.801
350.	55.764	14.015	69.779	4905.2	26.968
375.	56.763	14.949	71.712	5605.9	29.077
400.	57.758	15.896	73.654	6358.5	31.121
425.	58.750	16.850	75.600	7161.3	33.094
450.	59.740	17.806	77.546	8012.6	34.993
475.	60.729	18.759	79.487	8910.4	36.818
500.	61.715	19.706	81.421	9852.9	38.569
550.	63.681	21.572	85.253	11864.5	41.847
600.	65.636	23.388	89.024	14032.9	44.842
650.	67.578	25.145	92.723	16344.2	47.569
700.	69.504	26.837	96.340	18785.6	50.048
750.	71.411	28.460	99.871	21345.2	52.299
800.	73.298	30.015	103.313	24012.1	54.343
850.	75.163	31.502	106.664	26776.4	56.198
900.	77.004	32.921	109.925	29629.1	57.883
950.	78.820	34.276	113.096	32562.1	59.414
1000.	80.611	35.568	116.180	35568.2	60.806
1050.	82.377	36.801	119.177	38640.6	62.073
1100.	84.116	37.976	122.092	41773.6	63.228
1150.	85.829	39.097	124.926	44961.7	64.282
1200.	87.516	40.167	127.683	48200.3	65.246
1250.	89.176	41.188	130.364	51484.9	66.128
1300.	90.811	42.163	132.974	54811.8	66.936
1350.	92.420	43.094	135.514	58177.5	67.678
1400.	94.003	43.985	137.988	61578.7	68.361
1450.	95.562	44.836	140.398	65012.7	68.990
1500.	97.096	45.651	142.747	68476.8	69.569
1550.	98.605	46.432	145.037	71968.9	70.105
1600.	100.091	47.179	147.271	75486.7	70.601
1650.	101.554	47.896	149.450	79028.3	71.060
1700.	102.994	48.584	151.578	82592.1	71.486
1750.	104.412	49.244	153.656	86176.4	71.882
1800.	105.808	49.878	155.686	89779.9	72.251
1850.	107.183	50.487	157.670	93401.1	72.594
1900.	108.538	51.073	159.611	97038.9	72.914
1950.	109.872	51.637	161.509	100692.2	73.214
2000.	111.186	52.180	163.366	104359.9	73.494
2050.	112.481	52.703	165.184	108041.3	73.756

Table 20. B_5H_9(gas) [Continued]

T	$-(F^\circ-H_0^\circ)/T$	$(H^\circ-H_0^\circ)/T$	S°	$(H^\circ-H_0^\circ)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	113.757	53.207	166.964	111735.3	74.002
2150.	115.015	53.694	168.708	115441.2	74.233
2200.	116.254	54.163	170.417	119158.4	74.450
2250.	117.477	54.616	172.093	122886.0	74.655
2300.	118.682	55.054	173.736	126623.6	74.847
2350.	119.870	55.477	175.347	130370.5	75.028
2400.	121.043	55.886	176.929	134126.3	75.200
2450.	122.199	56.282	178.481	137890.3	75.361
2500.	123.340	56.665	180.005	141662.3	75.514
2600.	125.577	57.395	182.972	149228.1	75.797
2700.	127.756	58.082	185.838	156820.6	76.050
2800.	129.880	58.728	188.608	164437.3	76.279
2900.	131.952	59.336	191.288	172075.7	76.486
3000.	133.973	59.911	193.884	179733.9	76.674
3100.	135.946	60.455	196.401	187410.0	76.845
3200.	137.874	60.970	198.844	195102.4	77.001
3300.	139.758	61.458	201.215	202809.8	77.144
3400.	141.599	61.921	203.520	210530.9	77.275
3500.	143.401	62.361	205.762	218264.5	77.396
3600.	145.163	62.780	207.944	226009.7	77.507
3700.	146.889	63.180	210.069	233765.6	77.610
3800.	148.579	63.561	212.140	241531.4	77.704
3900.	150.235	63.925	214.159	249306.3	77.792
4000.	151.858	64.272	216.130	257089.6	77.874
4100.	153.449	64.605	218.054	264880.9	77.950
4200.	155.009	64.924	219.933	272679.5	78.021
4300.	156.541	65.229	221.770	280484.9	78.087
4400.	158.044	65.522	223.566	288296.6	78.148
4500.	159.519	65.803	225.322	296114.4	78.206
4600.	160.969	66.073	227.042	303937.8	78.260
4700.	162.392	66.333	228.726	311766.3	78.311
4800.	163.792	66.583	230.375	319599.9	78.359
4900.	165.167	66.824	231.991	327438.0	78.404
5000.	166.519	67.056	233.575	335280.5	78.446
5100.	167.849	67.280	235.129	343127.1	78.486
5200.	169.158	67.496	236.654	350977.6	78.524
5300.	170.446	67.704	238.150	358831.8	78.559
5400.	171.713	67.905	239.618	366689.4	78.593
5500.	172.961	68.100	241.061	374550.3	78.625
5600.	174.190	68.288	242.478	382414.3	78.655
5700.	175.400	68.470	243.870	390281.2	78.684
5800.	176.592	68.647	245.239	398151.0	78.711
5900.	177.767	68.818	246.585	406023.4	78.737
6000.	178.925	68.983	247.908	413898.3	78.761
273.15	52.645	11.317	63.962	3091.3	20.183
298.15	53.672	12.155	65.827	3623.9	22.424
296.00	53.584	12.081	65.665	3575.9	22.232

Table 21. $B_{10}H_{14}$(crystal)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
0.	0.0	0.0	0.0	0.0	0.0
50.	1.844	3.537	5.381	8.14	176.8
100.	5.509	7.210	12.719	13.28	721.0
150.	8.999	10.247	19.246	19.94	1537.0
200.	12.418	13.808	26.226	29.49	2761.6
250.	15.947	18.080	34.027	40.98	4520.0
300.	19.660	22.862	42.522	52.51	6858.6
350.	23.562	27.925	51.487	64.33	9773.8
371.93	25.328	30.246	55.574	70.15	11249.4
273.15	17.642	20.250	37.892	46.36	5531.3
298.15	19.520	22.681	42.201	52.09	6762.3

Table 22. $B_{10}H_{14}$(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	45.244	7.972	53.216	398.6	8.121
75.	48.503	8.153	56.656	611.5	9.076
100.	50.903	8.605	59.508	860.5	10.996
125.	52.897	9.343	62.240	1167.9	13.707
150.	54.685	10.341	65.026	1551.2	17.052
175.	56.369	11.570	67.938	2024.7	20.903
200.	58.005	12.997	71.002	2599.4	25.129
225.	59.626	14.591	74.218	3283.1	29.592
250.	61.252	16.320	77.572	4079.9	34.165
275.	62.893	18.150	81.043	4991.4	38.744
300.	64.553	20.055	84.608	6016.5	43.252
325.	66.235	22.009	88.244	7152.9	47.633
350.	67.939	23.991	91.930	8396.8	51.853
375.	69.662	25.984	95.646	9744.0	55.892
400.	71.403	27.975	99.377	11189.8	59.740
425.	73.158	29.952	103.110	12729.4	63.395
450.	74.925	31.907	106.832	14358.0	66.858
475.	76.702	33.833	110.536	16070.8	70.138
500.	78.486	35.727	114.213	17863.4	73.240
550.	82.065	39.401	121.466	21670.7	78.947
600.	85.645	42.913	128.558	25748.1	84.052
650.	89.213	46.257	135.470	30067.0	88.622
700.	92.758	49.432	142.190	34602.4	92.721
750.	96.272	52.443	148.715	39332.1	96.401
800.	99.749	55.296	155.044	44236.4	99.713
850.	103.183	57.998	161.180	49297.9	102.697
900.	106.571	60.557	167.128	54501.3	105.390
950.	109.911	62.982	172.892	59832.7	107.826
1000.	113.200	65.280	178.480	65280.0	110.032
1050.	116.438	67.459	183.898	70832.5	112.033
1100.	119.625	69.528	189.152	76480.3	113.853
1150.	122.759	71.491	194.250	82215.0	115.509
1200.	125.841	73.357	199.199	88028.8	117.020
1250.	128.872	75.132	204.004	93914.8	118.400
1300.	131.852	76.821	208.673	99866.9	119.663
1350.	134.782	78.429	213.211	105879.4	120.822
1400.	137.662	79.962	217.625	111947.5	121.886
1450.	140.494	81.425	221.919	118066.6	122.865
1500.	143.278	82.822	226.100	124232.7	123.767
1550.	146.016	84.156	230.172	130442.1	124.600
1600.	148.708	85.432	234.140	136691.6	125.370
1650.	151.355	86.653	238.009	142978.1	126.083
1700.	153.960	87.823	241.783	149299.0	126.744
1750.	156.522	88.944	245.466	155651.7	127.358
1800.	159.043	90.019	249.062	162034.1	127.929
1850.	161.523	91.051	252.574	168444.0	128.461
1900.	163.965	92.042	256.007	174879.6	128.958
1950.	166.368	92.994	259.362	181339.2	129.421
2000.	168.734	93.911	262.645	187821.2	129.855
2050.	171.064	94.792	265.856	194324.2	130.261

Table 22. $B_{10}H_{14}$(gas) [Continued]

T	$-\frac{(F°-H°_0)}{T}$	$\frac{(H°-H°_0)}{T}$	S°	$(H°-H°_0)$	$C°_p$
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	173.358	95.641	269.000	200846.9	130.641
2150.	175.618	96.460	272.078	207388.0	130.998
2200.	177.845	97.248	275.093	213946.3	131.334
2250.	180.039	98.009	278.048	220521.0	131.650
2300.	182.201	98.744	280.945	227111.0	131.947
2350.	184.332	99.453	283.786	233715.5	132.228
2400.	186.434	100.139	286.573	240333.5	132.492
2450.	188.505	100.802	289.307	246964.4	132.742
2500.	190.548	101.443	291.991	253607.5	132.978
2600.	194.551	102.664	297.215	266927.5	133.414
2700.	198.447	103.811	302.258	280288.8	133.806
2800.	202.242	104.888	307.131	293687.3	134.159
2900.	205.941	105.903	311.844	307119.4	134.478
3000.	209.547	106.861	316.408	320582.0	134.768
3100.	213.066	107.765	320.831	334072.2	135.032
3200.	216.501	108.621	325.122	347587.7	135.273
3300.	219.856	109.432	329.288	361126.2	135.494
3400.	223.135	110.202	333.336	374685.8	135.696
3500.	226.340	110.933	337.273	388264.8	135.882
3600.	229.475	111.628	341.103	401861.7	136.053
3700.	232.542	112.291	344.833	415474.9	136.211
3800.	235.545	112.922	348.467	429103.5	136.357
3900.	238.486	113.525	352.011	442746.0	136.493
4000.	241.368	114.100	355.468	456401.7	136.619
4100.	244.192	114.651	358.843	470069.4	136.736
4200.	246.961	115.178	362.139	483748.5	136.845
4300.	249.677	115.683	365.361	497438.1	136.946
4400.	252.343	116.168	368.510	511137.6	137.041
4500.	254.958	116.632	371.591	524846.2	137.130
4600.	257.527	117.079	374.606	538563.5	137.214
4700.	260.049	117.508	377.558	552288.8	137.292
4800.	262.528	117.921	380.449	566021.7	137.366
4900.	264.963	118.319	383.282	579761.8	137.435
5000.	267.357	118.702	386.059	593508.6	137.500
5100.	269.712	119.071	388.783	607261.7	137.561
5200.	272.027	119.427	391.454	621020.7	137.619
5300.	274.305	119.771	394.076	634785.4	137.674
5400.	276.547	120.103	396.650	648555.5	137.726
5500.	278.754	120.424	399.178	662330.6	137.775
5600.	280.927	120.734	401.661	676110.5	137.822
5700.	283.066	121.034	404.100	689894.9	137.866
5800.	285.174	121.325	406.499	703683.6	137.908
5900.	287.250	121.606	408.856	717476.4	137.948
6000.	289.296	121.879	411.175	731273.1	137.986
273.15	62.771	18.012	80.783	4920.0	38.407
298.15	64.430	19.912	84.342	5936.8	42.922
378.00	69.870	26.223	96.093	9912.4	56.364

Table 23. HOBO(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	34.330	7.943	42.273	397.2	7.949
75.	37.551	7.945	45.497	595.9	7.952
100.	39.837	7.950	47.787	795.0	7.984
125.	41.613	7.966	49.578	995.7	8.085
150.	43.068	8.000	51.068	1200.0	8.270
175.	44.305	8.056	52.361	1409.8	8.522
200.	45.385	8.132	53.517	1626.4	8.816
225.	46.348	8.226	54.574	1850.8	9.134
250.	47.220	8.333	55.553	2083.2	9.461
275.	48.020	8.450	56.470	2323.8	9.791
300.	48.761	8.576	57.336	2572.7	10.118
325.	49.452	8.707	58.159	2829.7	10.441
350.	50.102	8.842	58.944	3094.7	10.757
375.	50.717	8.980	59.697	3367.5	11.066
400.	51.301	9.120	60.421	3647.9	11.366
425.	51.858	9.260	61.119	3935.7	11.656
450.	52.392	9.401	61.793	4230.6	11.936
475.	52.904	9.542	62.446	4532.4	12.207
500.	53.397	9.682	63.078	4840.9	12.466
550.	54.332	9.957	64.290	5476.5	12.954
600.	55.210	10.226	65.436	6135.6	13.402
650.	56.039	10.486	66.526	6816.1	13.813
700.	56.826	10.738	67.563	7516.3	14.189
750.	57.575	10.979	68.554	8234.5	14.534
800.	58.291	11.212	69.502	8969.2	14.851
850.	58.977	11.434	70.412	9719.2	15.144
900.	59.637	11.648	71.285	10483.2	15.414
950.	60.272	11.853	72.125	11260.3	15.664
1000.	60.885	12.049	72.935	12049.3	15.896
1050.	61.478	12.238	73.715	12849.5	16.111
1100.	62.051	12.418	74.469	13660.1	16.311
1150.	62.607	12.592	75.199	14480.4	16.498
1200.	63.146	12.758	75.905	15309.7	16.672
1250.	63.671	12.918	76.588	16147.4	16.834
1300.	64.180	13.071	77.252	16992.9	16.986
1350.	64.676	13.219	77.895	17845.8	17.128
1400.	65.160	13.361	78.521	18705.5	17.260
1450.	65.631	13.498	79.129	19571.7	17.385
1500.	66.091	13.629	79.720	20443.9	17.501
1550.	66.540	13.756	80.296	21321.7	17.611
1600.	66.978	13.878	80.856	22204.8	17.713
1650.	67.407	13.996	81.403	23092.9	17.810
1700.	67.827	14.109	81.936	23985.7	17.901
1750.	68.237	14.219	82.456	24882.9	17.986
1800.	68.639	14.325	82.964	25784.3	18.066
1850.	69.033	14.427	83.460	26689.5	18.142
1900.	69.419	14.525	83.945	27598.4	18.214
1950.	69.798	14.621	84.419	28510.8	18.281
2000.	70.169	14.713	84.882	29426.4	18.345
2050.	70.534	14.803	85.336	30345.2	18.405

Table 23. HOBO(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	70.891	14.889	85.780	31266.9	18.462
2150.	71.243	14.973	86.215	32191.3	18.516
2200.	71.588	15.054	86.642	33118.4	18.567
2250.	71.927	15.132	87.059	34048.0	18.615
2300.	72.260	15.209	87.469	34979.9	18.661
2350.	72.588	15.283	87.871	35914.0	18.705
2400.	72.911	15.354	88.265	36850.3	18.746
2450.	73.228	15.424	88.652	37788.6	18.785
2500.	73.540	15.492	89.032	38728.8	18.823
2600.	74.151	15.621	89.772	40614.6	18.892
2700.	74.742	15.743	90.486	42507.0	18.955
2800.	75.317	15.859	91.176	44405.4	19.012
2900.	75.876	15.969	91.844	46309.3	19.065
3000.	76.419	16.073	92.491	48218.2	19.113
3100.	76.947	16.172	93.119	50131.7	19.156
3200.	77.462	16.265	93.728	52049.3	19.197
3300.	77.964	16.355	94.319	53970.9	19.234
3400.	78.454	16.440	94.894	55896.0	19.268
3500.	78.931	16.521	95.453	57824.4	19.300
3600.	79.398	16.599	95.997	59755.8	19.329
3700.	79.854	16.673	96.527	61690.1	19.356
3800.	80.299	16.744	97.043	63627.0	19.381
3900.	80.735	16.812	97.547	65566.2	19.404
4000.	81.162	16.877	98.039	67507.8	19.426
4100.	81.579	16.939	98.518	69451.4	19.447
4200.	81.988	16.999	98.987	71397.1	19.466
4300.	82.389	17.057	99.446	73344.5	19.483
4400.	82.781	17.112	99.894	75293.7	19.500
4500.	83.167	17.165	100.332	77244.5	19.516
4600.	83.544	17.217	100.761	79196.8	19.530
4700.	83.915	17.266	101.181	81150.5	19.544
4800.	84.279	17.314	101.593	83105.6	19.557
4900.	84.637	17.360	101.996	85061.9	19.569
5000.	84.988	17.404	102.392	87019.5	19.581
5100.	85.333	17.447	102.780	88978.1	19.592
5200.	85.672	17.488	103.160	90937.8	19.602
5300.	86.006	17.528	103.534	92898.5	19.612
5400.	86.334	17.567	103.900	94860.2	19.621
5500.	86.656	17.604	104.260	96822.8	19.630
5600.	86.974	17.640	104.614	98786.2	19.638
5700.	87.286	17.676	104.962	100750.4	19.646
5800.	87.594	17.710	105.304	102715.4	19.654
5900.	87.897	17.743	105.640	104681.1	19.661
6000.	88.196	17.775	105.970	106647.6	19.668
273.15	47.963	8.441	56.404	2305.7	9.766
298.15	48.708	8.566	57.274	2554.0	10.094

Table 24. H_3BO_3 (crystal)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
0.	0.0	0.0	0.0	0.0	0.0
50.	0.771	1.647	2.418	4.42	82.4
100.	2.734	4.206	6.940	8.60	420.6
150.	4.824	6.153	10.977	11.42	923.0
200.	6.832	7.797	14.629	14.05	1559.4
250.	8.737	9.315	18.052	16.74	2328.8
300.	10.566	10.787	21.353	19.55	3236.1
273.15	9.591	10.000	19.591	18.04	2731.5
298.15	10.499	10.734	21.233	19.45	3200.3

Table 25. H_3BO_3(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	37.931	8.003	45.934	400.2	8.295
75.	41.215	8.238	49.453	617.9	9.153
100.	43.630	8.577	52.207	857.7	10.018
125.	45.583	8.947	54.530	1118.3	10.829
150.	47.248	9.328	56.576	1399.2	11.648
175.	48.715	9.720	58.435	1701.0	12.497
200.	50.039	10.122	60.161	2024.3	13.377
225.	51.255	10.533	61.788	2370.0	14.276
250.	52.386	10.953	63.339	2738.2	15.181
275.	53.450	11.378	64.828	3129.0	16.081
300.	54.459	11.807	66.266	3542.1	16.963
325.	55.421	12.237	67.658	3977.0	17.820
350.	56.343	12.665	69.009	4432.8	18.645
375.	57.232	13.090	70.322	4908.9	19.434
400.	58.090	13.511	71.600	5404.2	20.183
425.	58.921	13.924	72.845	5917.7	20.891
450.	59.729	14.330	74.059	6448.4	21.560
475.	60.514	14.727	75.241	6995.4	22.189
500.	61.280	15.115	76.395	7557.6	22.782
550.	62.756	15.862	78.618	8724.3	23.864
600.	64.166	16.570	80.736	9941.9	24.826
650.	65.519	17.239	82.758	11205.1	25.686
700.	66.820	17.870	84.690	12509.1	26.461
750.	68.074	18.467	86.540	13850.0	27.164
800.	69.284	19.031	88.314	15224.5	27.807
850.	70.454	19.565	90.018	16629.8	28.397
900.	71.586	20.070	91.657	18063.4	28.941
950.	72.684	20.551	93.235	19523.2	29.444
1000.	73.750	21.007	94.757	21007.2	29.910
1050.	74.786	21.442	96.227	22513.7	30.344
1100.	75.793	21.856	97.648	24041.1	30.747
1150.	76.773	22.250	99.024	25588.0	31.123
1200.	77.728	22.628	100.356	27153.0	31.474
1250.	78.659	22.988	101.647	28735.0	31.801
1300.	79.568	23.333	102.900	30332.7	32.106
1350.	80.454	23.663	104.118	31945.2	32.391
1400.	81.321	23.980	105.300	33571.5	32.658
1450.	82.168	24.283	106.451	35210.7	32.907
1500.	82.996	24.575	107.570	36862.0	33.141
1550.	83.806	24.855	108.661	38524.6	33.360
1600.	84.600	25.124	109.723	40197.7	33.565
1650.	85.377	25.382	110.759	41880.8	33.757
1700.	86.138	25.631	111.769	43573.2	33.938
1750.	86.885	25.871	112.756	45274.4	34.107
1800.	87.617	26.102	113.719	46983.8	34.267
1850.	88.335	26.325	114.660	48700.9	34.417
1900.	89.040	26.540	115.579	50425.3	34.558
1950.	89.732	26.747	116.479	52156.6	34.691
2000.	90.412	26.947	117.359	53894.3	34.817
2050.	91.079	27.141	118.220	55638.1	34.935

Table 25. H_3BO_3(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	91.736	27.327	119.063	57387.7	35.047
2150.	92.381	27.508	119.889	59142.7	35.153
2200.	93.015	27.683	120.698	60902.9	35.253
2250.	93.639	27.852	121.492	62667.9	35.347
2300.	94.253	28.016	122.269	64437.5	35.437
2350.	94.857	28.175	123.032	66211.5	35.522
2400.	95.452	28.329	123.781	67989.6	35.602
2450.	96.038	28.478	124.516	69771.7	35.679
2500.	96.615	28.623	125.238	71557.5	35.752
2600.	97.743	28.900	126.643	75139.5	35.886
2700.	98.838	29.161	127.999	78734.3	36.009
2800.	99.903	29.407	129.311	82340.8	36.120
2900.	100.939	29.641	130.580	85957.9	36.221
3000.	101.948	29.862	131.810	89584.7	36.313
3100.	102.931	30.071	133.002	93220.3	36.397
3200.	103.889	30.270	134.158	96863.9	36.475
3300.	104.823	30.459	135.282	100515.0	36.546
3400.	105.735	30.639	136.374	104172.9	36.612
3500.	106.626	30.811	137.436	107837.2	36.672
3600.	107.496	30.974	138.470	111507.2	36.728
3700.	108.347	31.130	139.477	115182.6	36.780
3800.	109.179	31.280	140.459	118863.0	36.828
3900.	109.993	31.423	141.416	122548.1	36.872
4000.	110.790	31.559	142.350	126237.4	36.914
4100.	111.571	31.690	143.262	129930.8	36.953
4200.	112.337	31.816	144.153	133627.9	36.989
4300.	113.087	31.937	145.023	137328.5	37.023
4400.	113.822	32.053	145.875	141032.3	37.054
4500.	114.544	32.164	146.708	144739.3	37.084
4600.	115.252	32.272	147.523	148449.1	37.112
4700.	115.947	32.375	148.322	152161.6	37.138
4800.	116.630	32.474	149.104	155876.7	37.163
4900.	117.300	32.570	149.870	159594.2	37.186
5000.	117.959	32.663	150.622	163313.9	37.208
5100.	118.607	32.752	151.359	167035.8	37.229
5200.	119.244	32.838	152.082	170759.6	37.248
5300.	119.870	32.922	152.792	174485.4	37.267
5400.	120.486	33.002	153.489	178212.9	37.284
5500.	121.092	33.080	154.173	181942.2	37.301
5600.	121.689	33.156	154.845	185673.1	37.317
5700.	122.277	33.229	155.506	189405.5	37.332
5800.	122.855	33.300	156.155	193139.4	37.346
5900.	123.425	33.369	156.794	196874.7	37.359
6000.	123.986	33.435	157.422	200611.3	37.372
273.15	53.374	11.347	64.720	3099.3	16.015
298.15	54.386	11.775	66.161	3510.8	16.899

Table 26. $(HOBO)_3$(gas)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	45.169	8.035	53.204	401.7	8.474
75.	48.489	8.423	56.912	631.7	10.070
100.	51.000	9.106	60.105	910.6	12.319
125.	53.125	10.004	63.129	1250.5	14.913
150.	55.039	11.050	66.089	1657.5	17.655
175.	56.827	12.191	69.019	2133.5	20.423
200.	58.533	13.391	71.924	2678.3	23.148
225.	60.181	14.623	74.804	3290.2	25.789
250.	61.786	15.867	77.653	3966.8	28.318
275.	63.357	17.109	80.466	4705.0	30.716
300.	64.898	18.338	83.236	5501.4	32.970
325.	66.414	19.545	85.959	6352.2	35.072
350.	67.906	20.725	88.631	7253.7	37.022
375.	69.375	21.872	91.247	8202.0	38.822
400.	70.822	22.984	93.806	9193.6	40.477
425.	72.248	24.058	96.307	10224.8	41.997
450.	73.653	25.094	98.747	11292.3	43.389
475.	75.037	26.091	101.128	12393.3	44.665
500.	76.399	27.049	103.449	13524.7	45.834
550.	79.063	28.853	107.916	15869.3	47.892
600.	81.646	30.514	112.160	18308.6	49.634
650.	84.150	32.044	116.193	20828.4	51.121
700.	86.577	33.453	120.030	23417.4	52.405
750.	88.930	34.755	123.685	26066.2	53.524
800.	91.212	35.959	127.171	28767.6	54.510
850.	93.426	37.077	130.503	31515.4	55.385
900.	95.575	38.116	133.691	34304.6	56.170
950.	97.662	39.085	136.747	37131.1	56.879
1000.	99.690	39.991	139.681	39991.4	57.522
1050.	101.662	40.840	142.502	42882.4	58.110
1100.	103.580	41.638	145.218	45801.6	58.649
1150.	105.448	42.388	147.836	48746.6	59.144
1200.	107.267	43.096	150.363	51715.4	59.602
1250.	109.040	43.765	152.805	54706.2	60.025
1300.	110.769	44.398	155.167	57717.4	60.418
1350.	112.456	44.998	157.454	60747.6	60.783
1400.	114.103	45.568	159.671	63795.3	61.123
1450.	115.711	46.110	161.821	66859.5	61.440
1500.	117.283	46.626	163.909	69939.0	61.735
1550.	118.820	47.118	165.938	73032.7	62.012
1600.	120.324	47.587	167.911	76139.9	62.270
1650.	121.795	48.036	169.831	79259.5	62.513
1700.	123.235	48.465	171.701	82390.9	62.740
1750.	124.646	48.876	173.522	85533.2	62.953
1800.	126.029	49.270	175.299	88686.0	63.153
1850.	127.384	49.648	177.032	91848.4	63.342
1900.	128.713	50.011	178.723	95020.0	63.519
1950.	130.016	50.359	180.375	98200.2	63.686
2000.	131.295	50.694	181.990	101388.5	63.844
2050.	132.551	51.017	183.568	104584.4	63.993

Table 26. $(HOBO)_3$(gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	133.784	51.327	185.112	107787.6	64.133
2150.	134.996	51.627	186.622	110997.6	64.266
2200.	136.186	51.916	188.101	114214.1	64.392
2250.	137.356	52.194	189.550	117436.7	64.511
2300.	138.506	52.463	190.969	120665.1	64.624
2350.	139.637	52.723	192.360	123899.0	64.730
2400.	140.750	52.974	193.724	127138.0	64.832
2450.	141.844	53.217	195.062	130382.1	64.928
2500.	142.922	53.452	196.374	133630.8	65.020
2600.	145.027	53.901	198.928	140141.4	65.190
2700.	147.069	54.322	201.391	146668.2	65.344
2800.	149.052	54.718	203.770	153209.7	65.484
2900.	150.979	55.091	206.070	159764.6	65.612
3000.	152.852	55.444	208.296	166331.6	65.728
3100.	154.676	55.777	210.453	172909.9	65.835
3200.	156.452	56.093	212.545	179498.3	65.933
3300.	158.183	56.393	214.575	186096.2	66.023
3400.	159.870	56.677	216.548	192702.7	66.106
3500.	161.517	56.948	218.465	199317.2	66.183
3600.	163.125	57.205	220.330	205939.1	66.254
3700.	164.696	57.451	222.147	212567.8	66.319
3800.	166.231	57.685	223.916	219202.8	66.380
3900.	167.732	57.909	225.641	225843.7	66.437
4000.	169.201	58.123	227.324	232490.1	66.490
4100.	170.639	58.327	228.966	239141.5	66.539
4200.	172.047	58.523	230.570	245797.8	66.585
4300.	173.426	58.711	232.137	252458.5	66.628
4400.	174.778	58.892	233.670	259123.3	66.668
4500.	176.103	59.065	235.168	265792.1	66.706
4600.	177.403	59.231	236.635	272464.5	66.742
4700.	178.679	59.392	238.071	279140.4	66.775
4800.	179.931	59.546	239.477	285819.5	66.807
4900.	181.160	59.694	240.855	292501.6	66.836
5000.	182.368	59.837	242.205	299186.6	66.864
5100.	183.554	59.975	243.529	305874.4	66.890
5200.	184.720	60.109	244.829	312564.7	66.915
5300.	185.866	60.237	246.103	319257.4	66.939
5400.	186.993	60.362	247.355	325952.4	66.961
5500.	188.102	60.482	248.584	332649.6	66.982
5600.	189.193	60.598	249.791	339348.9	67.003
5700.	190.266	60.711	250.977	346050.1	67.022
5800.	191.323	60.820	252.143	352753.2	67.040
5900.	192.364	60.925	253.289	359458.0	67.057
6000.	193.389	61.027	254.416	366164.6	67.074
273.15	63.242	17.017	80.259	4648.3	30.543
298.15	64.785	18.248	83.033	5440.5	32.808

Table 27. BF(gas)

T	$-(F^\circ-H_0^\circ)/T$	$(H^\circ-H_0^\circ)/T$	S°	$(H^\circ-H_0^\circ)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	28.522	6.927	35.449	346.3	6.956
75.	31.333	6.937	38.270	520.3	6.957
100.	33.329	6.942	40.271	694.2	6.957
125.	34.879	6.945	41.824	868.1	6.958
150.	36.145	6.947	43.092	1042.1	6.959
175.	37.216	6.949	44.165	1216.1	6.961
200.	38.144	6.951	45.095	1390.2	6.968
225.	38.963	6.953	45.916	1564.5	6.982
250.	39.696	6.957	46.653	1739.3	7.004
275.	40.359	6.963	47.322	1914.8	7.035
300.	40.965	6.970	47.936	2091.1	7.076
325.	41.524	6.980	48.504	2268.7	7.125
350.	42.041	6.993	49.034	2447.5	7.182
375.	42.524	7.007	49.532	2627.8	7.244
400.	42.977	7.024	50.001	2809.7	7.309
425.	43.403	7.043	50.446	2993.3	7.377
450.	43.807	7.063	50.870	3178.5	7.445
475.	44.189	7.085	51.274	3365.5	7.514
500.	44.553	7.108	51.662	3554.2	7.582
550.	45.233	7.157	52.390	3936.6	7.712
600.	45.858	7.209	53.067	4325.2	7.833
650.	46.437	7.261	53.698	4719.7	7.943
700.	46.977	7.313	54.290	5119.3	8.043
750.	47.483	7.365	54.848	5523.8	8.133
800.	47.960	7.416	55.376	5932.5	8.213
850.	48.411	7.465	55.876	6344.9	8.285
900.	48.839	7.512	56.351	6760.8	8.350
950.	49.247	7.558	56.804	7179.8	8.408
1000.	49.635	7.602	57.237	7601.5	8.460
1050.	50.007	7.644	57.651	8025.7	8.507
1100.	50.364	7.684	58.048	8452.2	8.550
1150.	50.706	7.722	58.429	8880.6	8.588
1200.	51.036	7.759	58.795	9310.9	8.624
1250.	51.353	7.794	59.148	9742.9	8.656
1300.	51.660	7.828	59.488	10176.5	8.686
1350.	51.956	7.860	59.816	10611.5	8.713
1400.	52.242	7.891	60.133	11047.7	8.738
1450.	52.519	7.921	60.440	11485.2	8.761
1500.	52.788	7.949	60.738	11923.8	8.783
1550.	53.050	7.976	61.026	12363.5	8.803
1600.	53.303	8.003	61.306	12804.1	8.822
1650.	53.550	8.028	61.578	13245.7	8.840
1700.	53.790	8.052	61.842	13688.1	8.857
1750.	54.024	8.075	62.099	14131.3	8.872
1800.	54.251	8.097	62.349	14575.3	8.887
1850.	54.474	8.119	62.593	15020.1	8.901
1900.	54.690	8.140	62.830	15465.5	8.915
1950.	54.902	8.160	63.062	15911.5	8.928
2000.	55.109	8.179	63.288	16358.2	8.940
2050.	55.311	8.198	63.509	16805.5	8.952

Table 27. BF(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	55.509	8.216	63.725	17253.4	8.963
2150.	55.702	8.233	63.936	17701.8	8.974
2200.	55.892	8.250	64.142	18150.7	8.984
2250.	56.077	8.267	64.344	18600.2	8.994
2300.	56.259	8.283	64.542	19050.2	9.004
2350.	56.438	8.298	64.736	19500.6	9.014
2400.	56.612	8.313	64.926	19951.5	9.023
2450.	56.784	8.328	65.112	20402.9	9.032
2500.	56.952	8.342	65.294	20854.7	9.040
2600.	57.280	8.369	65.649	21759.6	9.057
2700.	57.596	8.395	65.991	22666.1	9.073
2800.	57.902	8.419	66.322	23574.2	9.089
2900.	58.198	8.443	66.641	24483.8	9.103
3000.	58.485	8.465	66.950	25394.8	9.118
3100.	58.763	8.486	67.249	26307.3	9.132
3200.	59.032	8.507	67.539	27221.2	9.146
3300.	59.294	8.526	67.821	28136.4	9.159
3400.	59.549	8.545	68.094	29053.0	9.172
3500.	59.797	8.563	68.360	29970.8	9.185
3600.	60.039	8.581	68.619	30890.0	9.198
3700.	60.274	8.597	68.871	31810.4	9.210
3800.	60.503	8.614	69.117	32732.1	9.223
3900.	60.727	8.629	69.357	33655.0	9.235
4000.	60.946	8.645	69.591	34579.1	9.247
4100.	61.160	8.660	69.819	35504.5	9.260
4200.	61.369	8.674	70.043	36431.0	9.272
4300.	61.573	8.688	70.261	37358.8	9.284
4400.	61.773	8.702	70.475	38287.8	9.296
4500.	61.968	8.715	70.684	39218.0	9.308
4600.	62.160	8.728	70.888	40149.4	9.320
4700.	62.348	8.741	71.089	41082.0	9.332
4800.	62.532	8.753	71.285	42015.7	9.344
4900.	62.713	8.765	71.478	42950.7	9.356
5000.	62.890	8.777	71.667	43886.9	9.368
5100.	63.064	8.789	71.853	44824.2	9.380
5200.	63.235	8.801	72.035	45762.8	9.392
5300.	63.402	8.812	72.214	46702.5	9.404
5400.	63.567	8.823	72.390	47643.5	9.416
5500.	63.729	8.834	72.563	48585.6	9.428
5600.	63.888	8.844	72.733	49529.0	9.440
5700.	64.045	8.855	72.900	50473.6	9.452
5800.	64.199	8.865	73.065	51419.4	9.464
5900.	64.351	8.876	73.227	52366.4	9.476
6000.	64.500	8.886	73.386	53314.6	9.488
273.15	40.312	6.962	47.275	1901.8	7.032
298.15	40.922	6.970	47.892	2078.1	7.073

Table 28. BF_2(gas)

T	$-\frac{(F^\circ-H_0^\circ)}{T}$	$\frac{(H^\circ-H_0^\circ)}{T}$	S°	$(H^\circ-H_0^\circ)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	36.074	7.943	44.017	397.1	7.949
75.	39.295	7.947	47.242	596.0	7.966
100.	41.583	7.960	49.543	796.0	8.045
125.	43.362	7.991	51.353	998.9	8.200
150.	44.823	8.043	52.866	1206.4	8.408
175.	46.068	8.112	54.180	1419.5	8.644
200.	47.157	8.193	55.350	1638.7	8.891
225.	48.127	8.285	56.412	1864.1	9.140
250.	49.005	8.383	57.387	2095.7	9.387
275.	49.808	8.485	58.294	2333.4	9.629
300.	50.551	8.590	59.142	2577.1	9.863
325.	51.243	8.697	59.940	2826.5	10.089
350.	51.891	8.804	60.696	3081.5	10.305
375.	52.503	8.911	61.414	3341.7	10.511
400.	53.081	9.017	62.098	3606.9	10.706
425.	53.631	9.122	62.753	3876.9	10.891
450.	54.155	9.225	63.380	4151.4	11.064
475.	54.657	9.326	63.983	4430.0	11.228
500.	55.138	9.425	64.563	4712.6	11.381
550.	56.045	9.616	65.661	5288.8	11.658
600.	56.889	9.796	66.686	5877.8	11.899
650.	57.680	9.966	67.647	6478.1	12.109
700.	58.425	10.126	68.551	7088.3	12.292
750.	59.129	10.276	69.405	7707.0	12.451
800.	59.796	10.416	70.213	8333.1	12.590
850.	60.432	10.548	70.980	8965.7	12.712
900.	61.038	10.671	71.709	9604.0	12.819
950.	61.618	10.787	72.405	10247.4	12.913
1000.	62.174	10.895	73.070	10895.1	12.996
1050.	62.709	10.997	73.705	11546.8	13.069
1100.	63.222	11.093	74.315	12201.9	13.135
1150.	63.717	11.183	74.900	12860.1	13.193
1200.	64.195	11.268	75.463	13521.1	13.245
1250.	64.657	11.348	76.004	14184.6	13.292
1300.	65.103	11.423	76.527	14850.3	13.335
1350.	65.536	11.495	77.031	15518.0	13.373
1400.	65.955	11.563	77.518	16187.5	13.408
1450.	66.362	11.627	77.989	16858.7	13.439
1500.	66.757	11.688	78.445	17531.4	13.468
1550.	67.141	11.745	78.887	18205.5	13.494
1600.	67.515	11.801	79.316	18880.8	13.518
1650.	67.879	11.853	79.732	19557.3	13.540
1700.	68.234	11.903	80.136	20234.8	13.561
1750.	68.579	11.950	80.530	20913.3	13.579
1800.	68.917	11.996	80.913	21592.7	13.597
1850.	69.246	12.039	81.285	22273.0	13.613
1900.	69.568	12.081	81.649	22954.0	13.627
1950.	69.882	12.121	82.003	23635.7	13.641
2000.	70.189	12.159	82.348	24318.1	13.654
2050.	70.490	12.196	82.686	25001.1	13.666

Table 28. BF_2(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	70.784	12.231	83.015	25684.6	13.677
2150.	71.072	12.265	83.337	26368.7	13.687
2200.	71.355	12.297	83.652	27053.3	13.697
2250.	71.631	12.328	83.960	27738.4	13.706
2300.	71.903	12.358	84.261	28423.9	13.715
2350.	72.169	12.387	84.556	29109.9	13.723
2400.	72.430	12.415	84.845	29796.2	13.730
2450.	72.686	12.442	85.128	30482.9	13.737
2500.	72.938	12.468	85.406	31169.9	13.744
2600.	73.428	12.517	85.945	32544.9	13.756
2700.	73.901	12.563	86.464	33921.1	13.767
2800.	74.359	12.607	86.965	35298.3	13.777
2900.	74.802	12.647	87.449	36676.5	13.786
3000.	75.231	12.685	87.916	38055.5	13.794
3100.	75.648	12.721	88.369	39435.2	13.801
3200.	76.052	12.755	88.807	40815.7	13.808
3300.	76.445	12.787	89.232	42196.8	13.814
3400.	76.827	12.817	89.645	43578.5	13.819
3500.	77.199	12.846	90.045	44960.7	13.825
3600.	77.562	12.873	90.435	46343.4	13.829
3700.	77.915	12.899	90.814	47726.5	13.834
3800.	78.259	12.924	91.183	49110.1	13.837
3900.	78.595	12.947	91.542	50494.0	13.841
4000.	78.923	12.970	91.893	51878.3	13.845
4100.	79.244	12.991	92.235	53262.9	13.848
4200.	79.557	13.011	92.568	54647.8	13.851
4300.	79.863	13.031	92.894	56033.0	13.853
4400.	80.163	13.050	93.213	57418.5	13.856
4500.	80.457	13.068	93.524	58804.2	13.858
4600.	80.744	13.085	93.829	60190.2	13.861
4700.	81.026	13.101	94.127	61576.3	13.863
4800.	81.302	13.117	94.419	62962.7	13.865
4900.	81.572	13.133	94.705	64349.3	13.867
5000.	81.838	13.147	94.985	65736.0	13.868
5100.	82.098	13.161	95.259	67122.9	13.870
5200.	82.354	13.175	95.529	68510.0	13.871
5300.	82.605	13.188	95.793	69897.2	13.873
5400.	82.852	13.201	96.052	71284.6	13.874
5500.	83.094	13.213	96.307	72672.1	13.876
5600.	83.332	13.225	96.557	74059.7	13.877
5700.	83.566	13.236	96.803	75447.4	13.878
5800.	83.797	13.247	97.044	76835.3	13.879
5900.	84.023	13.258	97.281	78223.2	13.880
6000.	84.246	13.269	97.515	79611.3	13.881
273.15	49.751	8.477	58.229	2315.6	9.612
298.15	50.498	8.582	59.081	2558.9	9.846

Table 29. BF_3 (gas)

T	$-\frac{(F^\circ-H_0^\circ)}{T}$	$\frac{(H^\circ-H_0^\circ)}{T}$	S°	$(H^\circ-H_0^\circ)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	36.674	7.946	44.620	397.3	7.950
75.	39.897	7.950	47.847	596.3	7.983
100.	42.187	7.976	50.162	797.6	8.148
125.	43.973	8.041	52.014	1005.1	8.484
150.	45.448	8.152	53.600	1222.8	8.947
175.	46.715	8.303	55.018	1453.0	9.478
200.	47.836	8.484	56.320	1696.9	10.030
225.	48.846	8.687	57.533	1954.5	10.578
250.	49.773	8.902	58.675	2225.6	11.107
275.	50.632	9.126	59.758	2509.6	11.613
300.	51.435	9.353	60.789	2806.0	12.092
325.	52.193	9.582	61.775	3114.0	12.545
350.	52.911	9.809	62.720	3433.0	12.972
375.	53.596	10.033	63.629	3762.4	13.374
400.	54.250	10.254	64.504	4101.5	13.753
425.	54.879	10.470	65.349	4449.8	14.108
450.	55.483	10.682	66.165	4806.8	14.441
475.	56.066	10.888	66.954	5171.7	14.753
500.	56.630	11.088	67.718	5544.2	15.045
550.	57.705	11.473	69.177	6309.9	15.572
600.	58.719	11.834	70.552	7100.3	16.031
650.	59.679	12.172	71.852	7912.0	16.430
700.	60.593	12.489	73.082	8742.4	16.778
750.	61.465	12.785	74.250	9589.0	17.080
800.	62.299	13.062	75.361	10449.8	17.345
850.	63.099	13.321	76.420	11323.0	17.577
900.	63.867	13.563	77.431	12207.0	17.780
950.	64.607	13.790	78.397	13100.6	17.959
1000.	65.320	14.003	79.322	14002.6	18.118
1050.	66.008	14.202	80.210	14912.1	18.258
1100.	66.673	14.389	81.062	15828.2	18.383
1150.	67.316	14.565	81.882	16750.2	18.495
1200.	67.940	14.731	82.671	17677.5	18.595
1250.	68.544	14.888	83.432	18609.5	18.685
1300.	69.131	15.035	84.166	19545.9	18.766
1350.	69.701	15.175	84.876	20486.0	18.840
1400.	70.255	15.307	85.562	21429.7	18.906
1450.	70.795	15.432	86.227	22376.6	18.967
1500.	71.320	15.551	86.871	23326.3	19.022
1550.	71.832	15.664	87.495	24278.7	19.072
1600.	72.331	15.771	88.102	25233.4	19.118
1650.	72.818	15.873	88.691	26190.4	19.160
1700.	73.293	15.970	89.263	27149.4	19.199
1750.	73.757	16.063	89.820	28110.3	19.235
1800.	74.211	16.152	90.363	29072.9	19.268
1850.	74.655	16.236	90.891	30037.1	19.299
1900.	75.089	16.317	91.406	31002.8	19.327
1950.	75.514	16.395	91.908	31969.8	19.354
2000.	75.930	16.469	92.399	32938.1	19.378
2050.	76.337	16.540	92.877	33907.6	19.401

Table 29. BF_3(gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	76.737	16.609	93.345	34878.2	19.423
2150.	77.128	16.674	93.802	35849.8	19.442
2200.	77.512	16.737	94.250	36822.4	19.461
2250.	77.889	16.798	94.687	37795.9	19.479
2300.	78.259	16.857	95.115	38770.3	19.495
2350.	78.622	16.913	95.535	39745.4	19.510
2400.	78.979	16.967	95.946	40721.3	19.525
2450.	79.329	17.020	96.349	41697.9	19.539
2500.	79.673	17.070	96.743	42675.1	19.551
2600.	80.345	17.166	97.511	44631.5	19.575
2700.	80.994	17.256	98.250	46590.1	19.596
2800.	81.623	17.340	98.963	48550.7	19.615
2900.	82.233	17.418	99.652	50513.0	19.632
3000.	82.825	17.492	100.317	52477.1	19.648
3100.	83.400	17.562	100.962	54442.5	19.662
3200.	83.958	17.628	101.586	56409.4	19.674
3300.	84.502	17.690	102.192	58377.4	19.686
3400.	85.031	17.749	102.780	60346.5	19.697
3500.	85.546	17.805	103.351	62316.7	19.707
3600.	86.048	17.858	103.906	64287.8	19.716
3700.	86.538	17.908	104.446	66259.8	19.724
3800.	87.017	17.956	104.972	68232.6	19.731
3900.	87.484	18.002	105.485	70206.1	19.738
4000.	87.940	18.045	105.985	72180.2	19.745
4100.	88.386	18.087	106.473	74155.0	19.751
4200.	88.822	18.126	106.949	76130.4	19.757
4300.	89.249	18.164	107.414	78106.4	19.762
4400.	89.667	18.201	107.868	80082.8	19.767
4500.	90.077	18.236	108.312	82059.8	19.772
4600.	90.478	18.269	108.747	84037.1	19.776
4700.	90.871	18.301	109.172	86014.9	19.780
4800.	91.257	18.332	109.589	87993.1	19.784
4900.	91.635	18.362	109.997	89971.7	19.787
5000.	92.006	18.390	110.396	91950.6	19.791
5100.	92.371	18.418	110.788	93929.8	19.794
5200.	92.729	18.444	111.173	95909.3	19.797
5300.	93.080	18.470	111.550	97889.2	19.800
5400.	93.426	18.494	111.920	99869.2	19.802
5500.	93.765	18.518	112.283	101849.6	19.805
5600.	94.099	18.541	112.640	103830.2	19.807
5700.	94.427	18.563	112.991	105811.0	19.809
5800.	94.750	18.585	113.335	107792.1	19.812
5900.	95.068	18.606	113.674	109773.3	19.814
6000.	95.381	18.626	114.007	111754.8	19.816
273.15	50.570	9.109	59.679	2488.2	11.576
298.15	51.378	9.336	60.714	2783.7	12.057
154.50	45.689	8.177	53.866	1263.3	9.039

Table 30. BOF(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	32.908	6.950	39.858	347.5	6.959
75.	35.728	6.962	42.689	522.1	7.037
100.	37.736	7.010	44.745	701.0	7.302
125.	39.309	7.107	46.417	888.4	7.709
150.	40.617	7.245	47.862	1086.7	8.158
175.	41.746	7.407	49.152	1296.2	8.591
200.	42.746	7.580	50.326	1516.0	8.987
225.	43.649	7.756	51.405	1745.2	9.344
250.	44.475	7.931	52.407	1982.9	9.665
275.	45.239	8.103	53.342	2228.2	9.957
300.	45.951	8.268	54.220	2480.5	10.223
325.	46.619	8.428	55.048	2739.2	10.467
350.	47.250	8.582	55.832	3003.7	10.692
375.	47.847	8.730	56.577	3273.6	10.902
400.	48.415	8.872	57.287	3548.7	11.098
425.	48.957	9.008	57.965	3828.4	11.282
450.	49.475	9.139	58.615	4112.7	11.455
475.	49.973	9.265	59.238	4401.1	11.618
500.	50.451	9.387	59.838	4693.5	11.772
550.	51.357	9.617	60.974	5289.3	12.056
600.	52.203	9.831	62.034	5898.6	12.310
650.	52.998	10.031	63.028	6519.9	12.537
700.	53.748	10.217	63.965	7151.9	12.741
750.	54.459	10.392	64.851	7793.6	12.924
800.	55.135	10.555	65.690	8444.0	13.088
850.	55.780	10.708	66.488	9102.2	13.235
900.	56.396	10.853	67.248	9767.3	13.367
950.	56.986	10.988	67.974	10438.7	13.486
1000.	57.553	11.116	68.669	11115.7	13.592
1050.	58.098	11.236	69.334	11797.7	13.688
1100.	58.624	11.349	69.973	12484.3	13.775
1150.	59.131	11.457	70.587	13175.1	13.853
1200.	59.620	11.558	71.178	13869.5	13.924
1250.	60.094	11.654	71.748	14567.4	13.989
1300.	60.553	11.745	72.298	15268.3	14.048
1350.	60.998	11.831	72.829	15972.1	14.101
1400.	61.430	11.913	73.343	16678.4	14.150
1450.	61.849	11.991	73.840	17387.0	14.195
1500.	62.257	12.065	74.322	18097.8	14.236
1550.	62.654	12.136	74.789	18810.6	14.274
1600.	63.040	12.203	75.243	19525.1	14.309
1650.	63.416	12.268	75.684	20241.4	14.341
1700.	63.784	12.329	76.113	20959.2	14.370
1750.	64.142	12.388	76.529	21678.4	14.398
1800.	64.492	12.444	76.935	22398.9	14.423
1850.	64.833	12.498	77.331	23120.7	14.447
1900.	65.167	12.549	77.717	23843.6	14.469
1950.	65.494	12.599	78.093	24567.5	14.489
2000.	65.813	12.646	78.460	25292.5	14.508
2050.	66.126	12.692	78.818	26018.3	14.526

Table 30. BOF(gas). [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	66.433	12.736	79.168	26745.0	14.543
2150.	66.733	12.778	79.511	27472.6	14.558
2200.	67.027	12.819	79.846	28200.9	14.573
2250.	67.316	12.858	80.173	28929.9	14.587
2300.	67.599	12.895	80.494	29659.5	14.600
2350.	67.876	12.932	80.808	30389.8	14.612
2400.	68.149	12.967	81.116	31120.7	14.623
2450.	68.417	13.001	81.418	31852.2	14.634
2500.	68.680	13.034	81.713	32584.2	14.644
2600.	69.192	13.096	82.288	34049.6	14.663
2700.	69.687	13.154	82.842	35516.7	14.680
2800.	70.167	13.209	83.376	36985.5	14.695
2900.	70.631	13.261	83.892	38455.7	14.709
3000.	71.082	13.309	84.391	39927.3	14.721
3100.	71.519	13.355	84.874	41400.0	14.733
3200.	71.943	13.398	85.342	42873.8	14.743
3300.	72.356	13.439	85.795	44348.6	14.752
3400.	72.758	13.478	86.236	45824.2	14.761
3500.	73.149	13.514	86.664	47300.7	14.769
3600.	73.531	13.549	87.080	48778.0	14.776
3700.	73.902	13.583	87.485	50255.9	14.783
3800.	74.265	13.614	87.879	51734.5	14.789
3900.	74.619	13.645	88.264	53213.7	14.795
4000.	74.965	13.673	88.638	54693.4	14.800
4100.	75.303	13.701	89.004	56173.7	14.805
4200.	75.633	13.727	89.360	57654.4	14.810
4300.	75.957	13.752	89.709	59135.6	14.814
4400.	76.273	13.777	90.050	60617.2	14.818
4500.	76.583	13.800	90.383	62099.2	14.822
4600.	76.886	13.822	90.708	63581.5	14.825
4700.	77.184	13.843	91.027	65064.2	14.828
4800.	77.476	13.864	91.340	66547.2	14.832
4900.	77.762	13.884	91.645	68030.5	14.834
5000.	78.042	13.903	91.945	69514.1	14.837
5100.	78.318	13.921	92.239	70997.9	14.840
5200.	78.588	13.939	92.527	72482.0	14.842
5300.	78.854	13.956	92.810	73966.4	14.845
5400.	79.115	13.972	93.087	75450.9	14.847
5500.	79.372	13.988	93.360	76935.7	14.849
5600.	79.624	14.004	93.627	78420.7	14.851
5700.	79.872	14.019	93.890	79905.8	14.853
5800.	80.116	14.033	94.149	81391.2	14.854
5900.	80.356	14.047	94.403	82876.7	14.856
6000.	80.592	14.060	94.652	84362.4	14.858
273.15	45.185	8.090	53.275	2209.8	9.936
298.15	45.900	8.256	54.156	2461.6	10.204
0.					

Table 31. $(BOF)_3$(gas)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	44.009	7.982	51.991	399.1	8.194
75.	47.282	8.227	55.508	617.0	9.423
100.	49.717	8.781	58.499	878.1	11.589
125.	51.761	9.602	61.363	1200.2	14.210
150.	53.597	10.593	64.190	1588.9	16.873
175.	55.310	11.672	66.982	2042.6	19.388
200.	56.941	12.784	69.725	2556.7	21.713
225.	58.511	13.897	72.408	3126.7	23.860
250.	60.033	14.994	75.026	3748.4	25.847
275.	61.512	16.065	77.577	4417.9	27.687
300.	62.955	17.105	80.060	5131.6	29.388
325.	64.364	18.111	82.475	5886.2	30.957
350.	65.742	19.081	84.823	6678.3	32.397
375.	67.090	20.013	87.104	7505.0	33.717
400.	68.411	20.908	89.319	8363.2	34.922
425.	69.704	21.765	91.469	9250.2	36.021
450.	70.971	22.585	93.557	10163.5	37.022
475.	72.214	23.370	95.583	11100.6	37.933
500.	73.432	24.119	97.551	12059.4	38.762
550.	75.797	25.518	101.315	14034.7	40.204
600.	78.073	26.793	104.866	16075.8	41.403
650.	80.264	27.957	108.221	18171.8	42.405
700.	82.375	29.020	111.395	20313.7	43.247
750.	84.411	29.992	114.404	22494.2	43.958
800.	86.376	30.885	117.260	24707.7	44.563
850.	88.273	31.705	119.978	26949.1	45.081
900.	90.107	32.461	122.568	29214.6	45.527
950.	91.881	33.159	125.040	31500.8	45.913
1000.	93.599	33.805	127.404	33805.0	46.250
1050.	95.263	34.405	129.667	36125.0	46.544
1100.	96.876	34.963	131.839	38458.9	46.803
1150.	98.442	35.482	133.924	40804.8	47.032
1200.	99.962	35.968	135.930	43161.6	47.235
1250.	101.440	36.422	137.862	45528.0	47.416
1300.	102.877	36.848	139.725	47902.9	47.578
1350.	104.275	37.249	141.524	50285.6	47.724
1400.	105.637	37.625	143.262	52675.1	47.855
1450.	106.963	37.980	144.943	55070.9	47.974
1500.	108.256	38.315	146.571	57472.3	48.081
1550.	109.518	38.632	148.150	59878.8	48.179
1600.	110.749	38.931	149.681	62290.1	48.268
1650.	111.952	39.215	151.167	64705.6	48.350
1700.	113.126	39.485	152.612	67125.0	48.425
1750.	114.275	39.742	154.016	69547.9	48.494
1800.	115.398	39.986	155.383	71974.2	48.557
1850.	116.496	40.218	156.715	74403.6	48.615
1900.	117.572	40.440	158.012	76835.7	48.669
1950.	118.625	40.651	159.277	79270.4	48.719
2000.	119.657	40.854	160.511	81707.6	48.766
2050.	120.668	41.047	161.715	84146.9	48.809

Table 31. $(BOF)_3$(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	121.660	41.233	162.892	86588.4	48.849
2150.	122.632	41.410	164.042	89031.8	48.887
2200.	123.586	41.580	165.166	91477.0	48.922
2250.	124.522	41.744	166.266	93924.0	48.955
2300.	125.441	41.901	167.342	96372.5	48.985
2350.	126.344	42.052	168.396	98822.5	49.014
2400.	127.231	42.197	169.428	101273.8	49.041
2450.	128.102	42.337	170.440	103726.5	49.067
2500.	128.959	42.472	171.431	106180.5	49.091
2600.	130.630	42.728	173.358	111091.8	49.135
2700.	132.247	42.966	175.213	116007.3	49.174
2800.	133.814	43.188	177.002	120926.5	49.209
2900.	135.333	43.396	178.729	125849.0	49.241
3000.	136.807	43.592	180.399	130774.5	49.269
3100.	138.240	43.775	182.015	135702.8	49.295
3200.	139.632	43.948	183.580	140633.5	49.319
3300.	140.987	44.111	185.098	145566.5	49.340
3400.	142.306	44.265	186.572	150501.5	49.360
3500.	143.592	44.411	188.003	155438.4	49.378
3600.	144.845	44.549	189.394	160377.1	49.394
3700.	146.067	44.680	190.747	165317.3	49.410
3800.	147.260	44.805	192.065	170258.9	49.424
3900.	148.426	44.924	193.349	175202.0	49.437
4000.	149.564	45.037	194.601	180146.2	49.449
4100.	150.678	45.144	195.822	185091.7	49.460
4200.	151.767	45.247	197.014	190038.2	49.470
4300.	152.833	45.346	198.178	194985.7	49.480
4400.	153.876	45.440	199.316	199934.1	49.489
4500.	154.899	45.530	200.428	204883.5	49.497
4600.	155.900	45.616	201.516	209833.6	49.505
4700.	156.882	45.699	202.581	214784.5	49.513
4800.	157.845	45.778	203.623	219736.1	49.520
4900.	158.790	45.855	204.645	224688.4	49.526
5000.	159.717	45.928	205.645	229641.3	49.532
5100.	160.627	45.999	206.626	234594.8	49.538
5200.	161.521	46.067	207.588	239548.9	49.543
5300.	162.399	46.133	208.532	244503.5	49.549
5400.	163.262	46.196	209.458	249458.6	49.553
5500.	164.110	46.257	210.367	254414.2	49.558
5600.	164.944	46.316	211.260	259370.2	49.562
5700.	165.765	46.373	212.138	264326.6	49.567
5800.	166.572	46.428	213.000	269283.5	49.570
5900.	167.366	46.481	213.847	274240.7	49.574
6000.	168.147	46.533	214.680	279198.3	49.578
273.15	61.404	15.987	77.391	4366.8	27.556
298.15	62.849	17.029	79.879	5077.3	29.267

Table 32. BCl (gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	31.392	6.943	38.335	347.1	6.956
75.	34.209	6.947	41.156	521.1	6.957
100.	36.208	6.950	43.158	695.0	6.959
125.	37.759	6.953	44.711	869.1	6.971
150.	39.027	6.958	45.985	1043.7	7.002
175.	40.100	6.968	47.068	1219.4	7.059
200.	41.031	6.984	48.016	1396.9	7.141
225.	41.855	7.007	48.862	1576.6	7.240
250.	42.595	7.036	49.631	1758.9	7.349
275.	43.267	7.069	50.337	1944.1	7.463
300.	43.884	7.107	50.991	2132.1	7.575
325.	44.454	7.147	51.601	2322.8	7.684
350.	44.985	7.189	52.175	2516.2	7.786
375.	45.483	7.232	52.715	2712.1	7.881
400.	45.951	7.275	53.227	2910.2	7.968
425.	46.393	7.319	53.712	3110.4	8.048
450.	46.813	7.361	54.174	3312.5	8.122
475.	47.212	7.403	54.615	3516.4	8.188
500.	47.593	7.444	55.037	3721.9	8.249
550.	48.306	7.522	55.828	4137.1	8.355
600.	48.964	7.595	56.559	4557.1	8.444
650.	49.574	7.663	57.238	4981.2	8.518
700.	50.145	7.727	57.871	5408.7	8.581
750.	50.680	7.786	58.465	5839.2	8.634
800.	51.184	7.840	59.024	6272.1	8.681
850.	51.661	7.891	59.552	6707.1	8.721
900.	52.113	7.938	60.051	7144.0	8.756
950.	52.544	7.982	60.525	7582.6	8.787
1000.	52.954	8.023	60.977	8022.7	8.815
1050.	53.346	8.061	61.407	8464.1	8.840
1100.	53.722	8.097	61.819	8906.6	8.862
1150.	54.083	8.131	62.214	9350.2	8.883
1200.	54.430	8.162	62.592	9794.9	8.902
1250.	54.763	8.192	62.956	10240.4	8.919
1300.	55.085	8.221	63.306	10686.7	8.935
1350.	55.396	8.247	63.643	11133.9	8.950
1400.	55.696	8.273	63.969	11581.7	8.964
1450.	55.987	8.297	64.284	12030.3	8.978
1500.	56.269	8.320	64.588	12479.4	8.990
1550.	56.542	8.341	64.883	12929.3	9.002
1600.	56.807	8.362	65.169	13379.7	9.014
1650.	57.065	8.382	65.447	13830.6	9.025
1700.	57.315	8.401	65.717	14282.1	9.035
1750.	57.559	8.419	65.979	14734.1	9.045
1800.	57.797	8.437	66.234	15186.6	9.055
1850.	58.028	8.454	66.482	15639.6	9.065
1900.	58.254	8.470	66.724	16093.1	9.074
1950.	58.474	8.486	66.959	16547.0	9.083
2000.	58.689	8.501	67.190	17001.4	9.092
2050.	58.899	8.515	67.414	17456.2	9.101

Table 32. BCl(gas) [Continued]

T	$-\frac{(F°-H°_0)}{T}$	$\frac{(H°-H°_0)}{T}$	S°	$(H°-H°_0)$	$C°_p$
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	59.104	8.529	67.634	17911.5	9.109
2150.	59.305	8.543	67.848	18367.2	9.118
2200.	59.502	8.556	68.058	18823.3	9.126
2250.	59.694	8.569	68.263	19279.8	9.134
2300.	59.883	8.581	68.464	19736.7	9.142
2350.	60.067	8.593	68.660	20194.0	9.150
2400.	60.248	8.605	68.853	20651.7	9.158
2450.	60.426	8.616	69.042	21109.8	9.166
2500.	60.600	8.627	69.227	21568.2	9.173
2600.	60.939	8.649	69.587	22486.3	9.189
2700.	61.266	8.669	69.934	23406.0	9.204
2800.	61.581	8.688	70.269	24327.1	9.219
2900.	61.886	8.707	70.593	25249.7	9.234
3000.	62.182	8.725	70.907	26173.8	9.248
3100.	62.468	8.742	71.210	27099.4	9.263
3200.	62.746	8.758	71.504	28026.5	9.278
3300.	63.016	8.774	71.790	28955.0	9.293
3400.	63.278	8.790	72.068	29885.0	9.307
3500.	63.533	8.805	72.338	30816.4	9.322
3600.	63.781	8.819	72.600	31749.3	9.337
3700.	64.023	8.833	72.857	32683.7	9.351
3800.	64.259	8.847	73.106	33619.6	9.366
3900.	64.489	8.861	73.350	34557.0	9.381
4000.	64.713	8.874	73.587	35495.9	9.396
4100.	64.933	8.887	73.819	36436.2	9.411
4200.	65.147	8.900	74.046	37378.1	9.426
4300.	65.356	8.912	74.268	38321.5	9.441
4400.	65.561	8.924	74.486	39266.4	9.457
4500.	65.762	8.936	74.698	40212.8	9.472
4600.	65.959	8.948	74.907	41160.8	9.487
4700.	66.151	8.960	75.111	42110.3	9.503
4800.	66.340	8.971	75.311	43061.3	9.519
4900.	66.525	8.982	75.508	44014.0	9.534
5000.	66.707	8.994	75.700	44968.2	9.550
5100.	66.885	9.005	75.890	45924.0	9.566
5200.	67.060	9.016	76.076	46881.4	9.582
5300.	67.232	9.026	76.258	47840.4	9.598
5400.	67.401	9.037	76.438	48801.1	9.614
5500.	67.566	9.048	76.614	49763.3	9.631
5600.	67.730	9.058	76.788	50727.2	9.647
5700.	67.890	9.069	76.959	51692.8	9.664
5800.	68.048	9.079	77.127	52660.0	9.681
5900.	68.203	9.090	77.293	53628.9	9.697
6000.	68.356	9.100	77.456	54599.5	9.714
273.15	43.219	7.067	50.286	1930.3	7.455
298.15	43.840	7.104	50.944	2118.1	7.567

Table 33. BCl_2(gas)

T	$-(F°-H°_0)/T$	$(H°-H°_0)/T$	S°	$(H°-H°_0)$	$C°_p$
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	40.631	7.961	48.592	398.0	8.045
75.	43.872	8.042	51.914	603.2	8.399
100.	46.204	8.188	54.392	818.8	8.854
125.	48.050	8.367	56.417	1045.9	9.306
150.	49.592	8.559	58.151	1283.8	9.722
175.	50.926	8.752	59.678	1531.6	10.096
200.	52.107	8.941	61.049	1788.3	10.431
225.	53.171	9.124	62.295	2052.9	10.734
250.	54.141	9.299	63.440	2324.7	11.009
275.	55.036	9.466	64.502	2603.1	11.258
300.	55.866	9.625	65.491	2887.5	11.484
325.	56.643	9.776	66.418	3177.2	11.689
350.	57.372	9.919	67.292	3471.7	11.874
375.	58.061	10.055	68.117	3770.7	12.041
400.	58.714	10.184	68.899	4073.6	12.192
425.	59.336	10.306	69.642	4380.2	12.328
450.	59.928	10.422	70.350	4689.9	12.450
475.	60.494	10.532	71.026	5002.6	12.560
500.	61.037	10.636	71.673	5317.8	12.660
550.	62.060	10.828	72.888	5955.3	12.832
600.	63.010	11.001	74.011	6600.5	12.973
650.	63.897	11.157	75.054	7252.2	13.090
700.	64.729	11.299	76.028	7909.2	13.187
750.	65.513	11.427	76.940	8570.6	13.269
800.	66.254	11.545	77.799	9235.8	13.338
850.	66.957	11.652	78.609	9904.3	13.397
900.	67.626	11.750	79.377	10575.4	13.448
950.	68.264	11.841	80.105	11248.9	13.491
1000.	68.873	11.924	80.798	11924.4	13.529
1050.	69.457	12.002	81.459	12601.7	13.562
1100.	70.017	12.073	82.090	13280.6	13.591
1150.	70.555	12.140	82.695	13960.8	13.617
1200.	71.073	12.202	83.275	14642.3	13.640
1250.	71.573	12.260	83.832	15324.8	13.660
1300.	72.054	12.314	84.368	16008.2	13.678
1350.	72.520	12.365	84.885	16692.5	13.694
1400.	72.971	12.413	85.383	17377.6	13.709
1450.	73.407	12.458	85.865	18063.4	13.722
1500.	73.830	12.500	86.330	18749.8	13.734
1550.	74.241	12.540	86.780	19436.8	13.745
1600.	74.639	12.578	87.217	20124.3	13.755
1650.	75.027	12.614	87.640	20812.3	13.764
1700.	75.404	12.647	88.051	21500.7	13.772
1750.	75.771	12.680	88.451	22189.5	13.780
1800.	76.129	12.710	88.839	22878.7	13.787
1850.	76.477	12.740	89.217	23568.2	13.793
1900.	76.817	12.767	89.585	24258.0	13.799
1950.	77.149	12.794	89.943	24948.1	13.805
2000.	77.474	12.819	90.293	25638.4	13.810
2050.	77.791	12.843	90.634	26329.1	13.815

Table 33. BCl_2(gas) [Continued]

T	$-\frac{(F°-H°_0)}{T}$	$\frac{(H°-H°_0)}{T}$	S°	$(H°-H°_0)$	$C°_p$
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	78.100	12.867	90.967	27019.9	13.819
2150.	78.403	12.889	91.292	27711.0	13.823
2200.	78.700	12.910	91.610	28402.2	13.827
2250.	78.990	12.931	91.921	29093.7	13.831
2300.	79.275	12.950	92.225	29785.3	13.834
2350.	79.553	12.969	92.522	30477.1	13.837
2400.	79.827	12.987	92.814	31169.0	13.840
2450.	80.095	13.005	93.099	31861.1	13.843
2500.	80.357	13.021	93.379	32553.4	13.846
2600.	80.869	13.053	93.922	33938.2	13.851
2700.	81.362	13.083	94.445	35323.5	13.855
2800.	81.838	13.110	94.949	36709.2	13.859
2900.	82.299	13.136	95.435	38095.2	13.862
3000.	82.745	13.161	95.905	39481.6	13.865
3100.	83.176	13.183	96.360	40868.3	13.868
3200.	83.595	13.205	96.800	42255.3	13.871
3300.	84.002	13.225	97.227	43642.5	13.873
3400.	84.397	13.244	97.641	45029.9	13.875
3500.	84.781	13.262	98.043	46417.6	13.877
3600.	85.155	13.279	98.434	47805.4	13.879
3700.	85.519	13.296	98.815	49193.4	13.881
3800.	85.874	13.311	99.185	50581.6	13.882
3900.	86.220	13.326	99.546	51969.9	13.884
4000.	86.557	13.340	99.897	53358.4	13.885
4100.	86.887	13.353	100.240	54747.0	13.886
4200.	87.209	13.366	100.575	56135.7	13.888
4300.	87.524	13.378	100.901	57524.5	13.889
4400.	87.831	13.389	101.221	58913.4	13.890
4500.	88.132	13.401	101.533	60302.4	13.891
4600.	88.427	13.411	101.838	61691.5	13.891
4700.	88.715	13.421	102.137	63080.7	13.892
4800.	88.998	13.431	102.429	64470.0	13.893
4900.	89.275	13.441	102.716	65859.3	13.894
5000.	89.547	13.450	102.997	67248.7	13.894
5100.	89.813	13.458	103.272	68638.2	13.895
5200.	90.075	13.467	103.542	70027.7	13.896
5300.	90.331	13.475	103.806	71417.3	13.896
5400.	90.583	13.483	104.066	72807.0	13.897
5500.	90.831	13.490	104.321	74196.7	13.897
5600.	91.074	13.498	104.571	75586.4	13.898
5700.	91.313	13.505	104.817	76976.2	13.898
5800.	91.548	13.511	105.059	78366.0	13.899
5900.	91.779	13.518	105.297	79755.9	13.899
6000.	92.006	13.524	105.530	81145.9	13.899
273.15	54.972	9.454	64.426	2582.3	11.240
298.15	55.807	9.613	65.420	2866.2	11.468

Table 34. BCl_3 (gas)

T	$-(F^\circ-H_0^\circ)/T$	$(H^\circ-H_0^\circ)/T$	S°	$(H^\circ-H_0^\circ)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	41.892	7.974	49.866	398.7	8.129
75.	45.149	8.130	53.279	609.7	8.824
100.	47.525	8.416	55.941	841.6	9.738
125.	49.441	8.773	58.214	1096.6	10.654
150.	51.074	9.158	60.232	1373.7	11.495
175.	52.515	9.547	62.061	1670.7	12.250
200.	53.815	9.927	63.742	1985.5	12.925
225.	55.005	10.295	65.300	2316.3	13.532
250.	56.108	10.646	66.755	2661.6	14.081
275.	57.139	10.982	68.120	3020.0	14.579
300.	58.108	11.301	69.409	3390.2	15.030
325.	59.025	11.603	70.628	3771.1	15.439
350.	59.895	11.891	71.786	4161.8	15.808
375.	60.725	12.163	72.888	4561.2	16.141
400.	61.518	12.421	73.940	4968.6	16.442
425.	62.279	12.666	74.945	5383.1	16.713
450.	63.009	12.898	75.907	5804.0	16.957
475.	63.713	13.117	76.830	6230.7	17.177
500.	64.391	13.325	77.716	6662.7	17.376
550.	65.679	13.710	79.389	7540.4	17.719
600.	66.887	14.056	80.943	8433.6	18.000
650.	68.025	14.369	82.393	9339.6	18.233
700.	69.100	14.652	83.752	10256.3	18.428
750.	70.120	14.909	85.029	11181.9	18.591
800.	71.090	15.144	86.233	12115.0	18.729
850.	72.014	15.358	87.373	13054.4	18.847
900.	72.898	15.555	88.453	13999.4	18.948
950.	73.744	15.736	89.480	14949.0	19.035
1000.	74.555	15.903	90.458	15902.7	19.111
1050.	75.335	16.057	91.392	16859.9	19.177
1100.	76.085	16.200	92.285	17820.2	19.235
1150.	76.808	16.333	93.142	18783.2	19.286
1200.	77.506	16.457	93.963	19748.7	19.331
1250.	78.180	16.573	94.753	20716.3	19.372
1300.	78.832	16.681	95.514	21685.8	19.408
1350.	79.464	16.783	96.247	22657.0	19.440
1400.	80.076	16.878	96.954	23629.8	19.469
1450.	80.670	16.968	97.638	24603.9	19.496
1500.	81.247	17.053	98.299	25579.3	19.520
1550.	81.807	17.133	98.940	26555.9	19.541
1600.	82.352	17.208	99.561	27533.4	19.561
1650.	82.883	17.280	100.163	28511.9	19.579
1700.	83.400	17.348	100.748	29491.3	19.596
1750.	83.904	17.412	101.316	30471.5	19.611
1800.	84.395	17.474	101.868	31452.4	19.625
1850.	84.874	17.532	102.406	32434.0	19.638
1900.	85.343	17.587	102.930	33416.2	19.650
1950.	85.800	17.640	103.441	34398.9	19.661
2000.	86.248	17.691	103.939	35382.2	19.671
2050.	86.685	17.740	104.425	36366.0	19.681

Table 34. BCl_3(gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	87.113	17.786	104.899	37350.3	19.690
2150.	87.532	17.830	105.362	38335.0	19.698
2200.	87.942	17.873	105.815	39320.1	19.706
2250.	88.345	17.914	106.258	40305.5	19.713
2300.	88.739	17.953	106.691	41291.3	19.720
2350.	89.125	17.990	107.116	42277.5	19.726
2400.	89.504	18.027	107.531	43263.9	19.732
2450.	89.876	18.061	107.938	44250.6	19.737
2500.	90.242	18.095	108.337	45237.6	19.743
2600.	90.953	18.159	109.111	47212.4	19.752
2700.	91.639	18.218	109.857	49188.1	19.761
2800.	92.303	18.273	110.576	51164.6	19.769
2900.	92.945	18.325	111.270	53141.8	19.776
3000.	93.567	18.373	111.940	55119.7	19.782
3100.	94.170	18.419	112.589	57098.2	19.788
3200.	94.755	18.462	113.217	59077.3	19.793
3300.	95.324	18.502	113.826	61056.8	19.798
3400.	95.877	18.540	114.417	63036.8	19.802
3500.	96.415	18.576	114.991	65017.2	19.806
3600.	96.939	18.611	115.549	66998.0	19.810
3700.	97.449	18.643	116.092	68979.1	19.813
3800.	97.947	18.674	116.621	70960.6	19.816
3900.	98.432	18.703	117.135	72942.3	19.819
4000.	98.906	18.731	117.637	74924.3	19.821
4100.	99.369	18.758	118.127	76906.6	19.824
4200.	99.821	18.783	118.604	78889.1	19.826
4300.	100.264	18.807	119.071	80871.8	19.828
4400.	100.696	18.831	119.527	82854.8	19.830
4500.	101.120	18.853	119.973	84837.9	19.832
4600.	101.534	18.874	120.408	86821.2	19.834
4700.	101.940	18.895	120.835	88804.7	19.836
4800.	102.338	18.914	121.253	90788.3	19.837
4900.	102.729	18.933	121.662	92772.1	19.838
5000.	103.111	18.951	122.062	94756.0	19.840
5100.	103.487	18.969	122.455	96740.0	19.841
5200.	103.855	18.985	122.841	98724.2	19.842
5300.	104.217	19.002	123.219	100708.5	19.843
5400.	104.572	19.017	123.590	102692.9	19.844
5500.	104.921	19.032	123.954	104677.4	19.846
5600.	105.264	19.047	124.311	106662.0	19.846
5700.	105.602	19.061	124.663	108646.7	19.847
5800.	105.933	19.074	125.008	110631.5	19.848
5900.	106.260	19.088	125.347	112616.3	19.849
6000.	106.580	19.100	125.681	114601.3	19.850
273.15	57.065	10.957	68.022	2993.0	14.544
298.15	58.038	11.278	69.316	3362.4	14.998
285.70	57.561	11.120	68.681	3177.0	14.778

Table 35. B_2Cl_4(gas)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	47.808	9.519	57.327	476.0	10.700
75.	51.815	10.194	62.009	764.5	12.420
100.	54.849	10.968	65.817	1096.8	14.133
125.	57.365	11.756	69.121	1469.5	15.649
150.	59.553	12.518	72.072	1877.7	16.990
175.	61.510	13.246	74.756	2318.0	18.200
200.	63.298	13.933	77.231	2786.7	19.291
225.	64.948	14.586	79.534	3281.9	20.294
250.	66.487	15.203	81.690	3800.8	21.203
275.	67.935	15.786	83.721	4341.2	22.029
300.	69.303	16.339	85.642	4901.7	22.780
325.	70.604	16.860	87.465	5479.6	23.457
350.	71.843	17.355	89.199	6074.4	24.067
375.	73.033	17.821	90.854	6682.8	24.619
400.	74.177	18.261	92.437	7304.2	25.116
425.	75.283	18.678	93.961	7938.2	25.562
450.	76.339	19.071	95.411	8582.1	25.966
475.	77.357	19.443	96.800	9235.5	26.331
500.	78.339	19.795	98.134	9897.7	26.660
550.	80.196	20.449	100.644	11246.7	27.222
600.	81.954	21.033	102.986	12619.5	27.688
650.	83.615	21.559	105.175	14013.4	28.075
700.	85.191	22.036	107.227	15425.1	28.398
750.	86.689	22.469	109.158	16851.6	28.669
800.	88.117	22.864	110.981	18290.8	28.898
850.	89.482	23.225	112.706	19740.8	29.092
900.	90.787	23.556	114.343	21200.2	29.258
950.	92.038	23.860	115.898	22666.9	29.403
1000.	93.239	24.140	117.380	24140.2	29.529
1050.	94.394	24.400	118.794	25619.5	29.639
1100.	95.506	24.640	120.146	27104.0	29.736
1150.	96.579	24.864	121.442	28593.0	29.822
1200.	97.614	25.072	122.686	30086.1	29.897
1250.	98.615	25.266	123.881	31582.8	29.965
1300.	99.582	25.448	125.031	33083.0	30.025
1350.	100.521	25.619	126.140	34585.7	30.079
1400.	101.431	25.779	127.211	36091.0	30.128
1450.	102.315	25.930	128.245	37598.6	30.172
1500.	103.174	26.072	129.246	39108.3	30.212
1550.	104.009	26.206	130.215	40619.9	30.248
1600.	104.821	26.333	131.155	42133.2	30.281
1650.	105.613	26.453	132.066	43648.1	30.311
1700.	106.384	26.567	132.951	45164.4	30.339
1750.	107.136	26.675	133.811	46682.0	30.365
1800.	107.869	26.778	134.647	48200.9	30.388
1850.	108.586	26.876	135.462	49721.3	30.409
1900.	109.286	26.970	136.255	51242.3	30.429
1950.	109.969	27.059	137.028	52764.3	30.448
2000.	110.638	27.144	137.781	54287.1	30.465
2050.	111.291	27.225	138.516	55810.7	30.481

Table 35. B_2Cl_4(gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	111.931	27.302	139.234	57335.1	30.496
2150.	112.558	27.377	139.935	58860.3	30.510
2200.	113.172	27.448	140.620	60386.0	30.523
2250.	113.773	27.517	141.290	61912.4	30.535
2300.	114.363	27.582	141.945	63439.4	30.546
2350.	114.942	27.645	142.587	64966.9	30.557
2400.	115.509	27.706	143.215	66494.9	30.567
2450.	116.066	27.765	143.831	68023.4	30.576
2500.	116.613	27.821	144.434	69552.3	30.585
2600.	117.677	27.927	145.605	72611.5	30.601
2700.	118.705	28.027	146.732	75672.1	30.616
2800.	119.699	28.119	147.819	78734.2	30.629
2900.	120.661	28.206	148.867	81797.4	30.640
3000.	121.594	28.287	149.881	84861.8	30.651
3100.	122.499	28.363	150.861	87924.1	30.660
3200.	123.376	28.434	151.811	90990.3	30.669
3300.	124.229	28.502	152.731	94057.5	30.677
3400.	125.058	28.566	153.624	97125.4	30.684
3500.	125.865	28.627	154.492	100194.1	30.691
3600.	126.650	28.684	155.335	103263.4	30.697
3700.	127.416	28.739	156.155	106333.3	30.702
3800.	128.162	28.790	156.953	109403.8	30.708
3900.	128.891	28.840	157.730	112474.8	30.712
4000.	129.602	28.887	158.488	115546.2	30.717
4100.	130.296	28.931	159.227	118618.2	30.721
4200.	130.975	28.974	159.949	121690.5	30.725
4300.	131.638	29.015	160.653	124763.2	30.728
4400.	132.288	29.054	161.341	127836.3	30.732
4500.	132.923	29.091	162.014	130909.6	30.735
4600.	133.545	29.127	162.672	133983.3	30.738
4700.	134.155	29.161	163.316	137057.3	30.740
4800.	134.753	29.194	163.947	140131.6	30.743
4900.	135.338	29.226	164.564	143206.1	30.745
5000.	135.913	29.256	165.169	146280.8	30.748
5100.	136.476	29.285	165.762	149355.8	30.750
5200.	137.030	29.314	166.343	152431.0	30.752
5300.	137.573	29.341	166.914	155506.3	30.754
5400.	138.106	29.367	167.473	158581.9	30.755
5500.	138.631	29.392	168.023	161657.6	30.757
5600.	139.146	29.417	168.562	164733.6	30.759
5700.	139.652	29.440	169.092	167809.6	30.760
5800.	140.150	29.463	169.613	170885.8	30.762
5900.	140.640	29.485	170.125	173962.2	30.763
6000.	141.122	29.506	170.628	177038.7	30.764
273.15	67.831	15.744	83.575	4300.5	21.971
298.15	69.204	16.299	85.504	4859.6	22.727
220.00	64.627	14.459	79.086	3181.0	20.102

Table 36. BOCl (gas)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	35.029	6.953	41.981	347.6	6.962
75.	37.850	6.971	44.821	522.8	7.093
100.	39.864	7.046	46.911	704.6	7.494
125.	41.451	7.193	48.644	899.1	8.085
150.	42.780	7.395	50.175	1109.3	8.724
175.	43.937	7.629	51.565	1335.0	9.322
200.	44.972	7.874	52.845	1574.7	9.844
225.	45.913	8.118	54.031	1826.5	10.285
250.	46.781	8.354	55.134	2088.4	10.654
275.	47.587	8.577	56.165	2358.7	10.963
300.	48.343	8.787	57.130	2636.2	11.224
325.	49.054	8.983	58.037	2919.6	11.447
350.	49.727	9.166	58.893	3208.3	11.641
375.	50.365	9.337	59.702	3501.5	11.812
400.	50.973	9.497	60.469	3798.7	11.966
425.	51.553	9.646	61.199	4099.6	12.106
450.	52.108	9.787	61.895	4403.9	12.235
475.	52.641	9.919	62.560	4711.3	12.355
500.	53.153	10.043	63.196	5021.6	12.468
550.	54.121	10.273	64.394	5650.3	12.675
600.	55.024	10.481	65.505	6288.7	12.860
650.	55.871	10.671	66.541	6936.0	13.028
700.	56.668	10.845	67.513	7591.3	13.181
750.	57.422	11.005	68.427	8253.8	13.318
800.	58.137	11.154	69.290	8922.9	13.443
850.	58.817	11.292	70.109	9598.0	13.556
900.	59.466	11.420	70.887	10278.4	13.658
950.	60.087	11.541	71.628	10963.7	13.751
1000.	60.682	11.653	72.335	11653.3	13.835
1050.	61.253	11.759	73.012	12347.0	13.911
1100.	61.802	11.858	73.661	13044.3	13.980
1150.	62.332	11.952	74.284	13744.9	14.042
1200.	62.842	12.040	74.882	14448.4	14.099
1250.	63.335	12.124	75.459	15154.7	14.151
1300.	63.812	12.203	76.015	15863.4	14.198
1350.	64.274	12.277	76.552	16574.5	14.242
1400.	64.722	12.348	77.070	17287.6	14.281
1450.	65.157	12.416	77.572	18002.5	14.318
1500.	65.579	12.480	78.058	18719.3	14.351
1550.	65.989	12.540	78.529	19437.6	14.382
1600.	66.388	12.598	78.986	20157.5	14.411
1650.	66.776	12.654	79.430	20878.6	14.437
1700.	67.155	12.707	79.861	21601.1	14.461
1750.	67.524	12.757	80.281	22324.7	14.484
1800.	67.884	12.805	80.689	23049.4	14.505
1850.	68.236	12.851	81.087	23775.2	14.524
1900.	68.579	12.896	81.475	24501.8	14.542
1950.	68.914	12.938	81.852	25229.3	14.559
2000.	69.242	12.979	82.221	25957.7	14.575
2050.	69.563	13.018	82.581	26686.8	14.589

Table 36. BOCl(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	69.878	13.056	82.933	27416.6	14.603
2150.	70.185	13.092	83.277	28147.1	14.616
2200.	70.487	13.126	83.613	28878.2	14.628
2250.	70.782	13.160	83.942	29609.9	14.640
2300.	71.072	13.192	84.264	30342.2	14.650
2350.	71.356	13.223	84.579	31074.9	14.660
2400.	71.634	13.253	84.888	31808.2	14.670
2450.	71.908	13.282	85.190	32541.9	14.679
2500.	72.176	13.310	85.487	33276.1	14.687
2600.	72.700	13.364	86.063	34745.6	14.703
2700.	73.205	13.414	86.618	36216.6	14.717
2800.	73.694	13.460	87.154	37689.0	14.730
2900.	74.167	13.504	87.671	39162.5	14.741
3000.	74.625	13.546	88.171	40637.2	14.751
3100.	75.070	13.585	88.655	42112.8	14.761
3200.	75.502	13.622	89.124	43589.3	14.769
3300.	75.922	13.657	89.578	45066.6	14.777
3400.	76.330	13.690	90.019	46544.7	14.784
3500.	76.727	13.721	90.448	48023.5	14.791
3600.	77.114	13.751	90.865	49502.9	14.797
3700.	77.491	13.779	91.270	50982.9	14.803
3800.	77.859	13.806	91.665	52463.4	14.808
3900.	78.218	13.832	92.050	53944.4	14.813
4000.	78.568	13.856	92.425	55425.9	14.817
4100.	78.911	13.880	92.791	56907.8	14.821
4200.	79.246	13.902	93.148	58390.1	14.825
4300.	79.573	13.924	93.497	59872.8	14.829
4400.	79.893	13.945	93.838	61355.8	14.832
4500.	80.207	13.964	94.171	62839.2	14.835
4600.	80.514	13.983	94.497	64322.8	14.838
4700.	80.815	14.001	94.816	65806.8	14.841
4800.	81.110	14.019	95.129	67291.0	14.843
4900.	81.399	14.036	95.435	68775.4	14.846
5000.	81.683	14.052	95.735	70260.1	14.848
5100.	81.961	14.068	96.029	71745.1	14.850
5200.	82.235	14.083	96.317	73230.2	14.852
5300.	82.503	14.097	96.600	74715.5	14.854
5400.	82.767	14.111	96.878	76201.0	14.856
5500.	83.026	14.125	97.151	77686.7	14.858
5600.	83.280	14.138	97.418	79172.6	14.859
5700.	83.531	14.151	97.681	80658.6	14.861
5800.	83.777	14.163	97.940	82144.8	14.862
5900.	84.019	14.175	98.194	83631.1	14.864
6000.	84.257	14.186	98.444	85117.5	14.865
273.15	47.530	8.561	56.091	2338.5	10.942
298.15	48.289	8.772	57.061	2615.4	11.206

Table 37. $(BOCl)_3$(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	47.148	7.982	55.131	399.1	8.197
75.	50.422	8.237	58.660	617.8	9.506
100.	52.866	8.842	61.708	884.2	11.965
125.	54.934	9.771	64.705	1221.4	15.067
150.	56.815	10.921	67.736	1638.2	18.259
175.	58.592	12.186	70.778	2132.5	21.237
200.	60.304	13.487	73.792	2697.5	23.906
225.	61.968	14.779	76.747	3325.3	26.270
250.	63.590	16.035	79.625	4008.7	28.366
275.	65.176	17.242	82.418	4741.6	30.231
300.	66.726	18.395	85.121	5518.6	31.898
325.	68.242	19.493	87.734	6335.1	33.393
350.	69.725	20.534	90.259	7187.0	34.735
375.	71.176	21.522	92.697	8070.7	35.942
400.	72.595	22.458	95.052	8983.1	37.029
425.	73.983	23.344	97.327	9921.3	38.009
450.	75.341	24.184	99.525	10882.8	38.893
475.	76.670	24.979	101.650	11865.3	39.692
500.	77.971	25.733	103.704	12866.7	40.414
550.	80.490	27.127	107.617	14919.7	41.662
600.	82.905	28.382	111.287	17029.3	42.692
650.	85.223	29.517	114.739	19185.9	43.548
700.	87.448	30.545	117.994	21381.7	44.264
750.	89.588	31.481	121.069	23610.4	44.867
800.	91.647	32.334	123.981	25867.0	45.380
850.	93.631	33.114	126.746	28147.2	45.818
900.	95.545	33.831	129.375	30447.7	46.194
950.	97.392	34.490	131.882	32765.7	46.520
1000.	99.177	35.099	134.276	35098.9	46.803
1050.	100.903	35.662	136.565	37445.4	47.051
1100.	102.574	36.185	138.759	39803.5	47.269
1150.	104.193	36.671	140.865	42171.9	47.461
1200.	105.764	37.124	142.888	44549.3	47.632
1250.	107.288	37.548	144.836	46934.7	47.784
1300.	108.768	37.944	146.713	49327.4	47.920
1350.	110.208	38.316	148.523	51726.5	48.042
1400.	111.607	38.665	150.273	54131.4	48.152
1450.	112.970	38.994	151.964	56541.5	48.252
1500.	114.297	39.304	153.601	58956.4	48.342
1550.	115.591	39.597	155.188	61375.6	48.424
1600.	116.852	39.874	156.727	63798.6	48.499
1650.	118.083	40.137	158.220	66225.3	48.567
1700.	119.285	40.385	159.671	68655.3	48.630
1750.	120.459	40.622	161.081	71088.2	48.687
1800.	121.607	40.847	162.454	73523.9	48.740
1850.	122.729	41.061	163.790	75962.2	48.789
1900.	123.827	41.265	165.091	78402.8	48.834
1950.	124.901	41.459	166.361	80845.6	48.876
2000.	125.953	41.645	167.598	83290.4	48.915
2050.	126.984	41.823	168.807	85737.0	48.951

Table 37. $(BOCl)_3$(gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	127.994	41.993	169.987	88185.5	48.985
2150.	128.984	42.156	171.140	90635.5	49.017
2200.	129.955	42.312	172.267	93087.1	49.046
2250.	130.907	42.462	173.370	95540.1	49.073
2300.	131.842	42.606	174.448	97994.4	49.099
2350.	132.760	42.745	175.505	100450.0	49.123
2400.	133.661	42.878	176.539	102906.7	49.146
2450.	134.547	43.006	177.553	105364.5	49.167
2500.	135.417	43.129	178.546	107823.4	49.187
2600.	137.113	43.363	180.476	112744.0	49.224
2700.	138.754	43.581	182.334	117668.1	49.257
2800.	140.342	43.784	184.126	122595.3	49.286
2900.	141.882	43.974	185.856	127525.3	49.313
3000.	143.376	44.153	187.528	132457.8	49.337
3100.	144.826	44.320	189.147	137392.6	49.359
3200.	146.236	44.478	190.714	142329.4	49.378
3300.	147.607	44.627	192.234	147268.2	49.396
3400.	148.941	44.767	193.709	152208.6	49.413
3500.	150.241	44.900	195.141	157150.6	49.428
3600.	151.508	45.026	196.534	162094.1	49.441
3700.	152.743	45.146	197.889	167038.9	49.454
3800.	153.948	45.259	199.208	171984.9	49.466
3900.	155.125	45.367	200.493	176932.0	49.477
4000.	156.275	45.470	201.745	181880.2	49.487
4100.	157.399	45.568	202.967	186829.4	49.496
4200.	158.499	45.662	204.160	191779.4	49.505
4300.	159.574	45.751	205.325	196730.3	49.513
4400.	160.627	45.837	206.464	201682.0	49.520
4500.	161.658	45.919	207.577	206634.4	49.527
4600.	162.668	45.997	208.665	211587.5	49.534
4700.	163.658	46.073	209.731	216541.2	49.540
4800.	164.629	46.145	210.774	221495.5	49.546
4900.	165.581	46.214	211.795	226450.4	49.552
5000.	166.515	46.281	212.796	231405.8	49.557
5100.	167.432	46.345	213.778	236361.7	49.561
5200.	168.333	46.407	214.740	241318.1	49.566
5300.	169.217	46.467	215.684	246274.9	49.570
5400.	170.087	46.524	216.611	251232.2	49.574
5500.	170.941	46.580	217.521	256189.8	49.578
5600.	171.781	46.634	218.414	261147.8	49.582
5700.	172.606	46.685	219.292	266106.1	49.585
5800.	173.419	46.735	220.154	271064.9	49.589
5900.	174.218	46.784	221.002	276023.9	49.592
6000.	175.005	46.831	221.835	280983.2	49.595
273.15	65.059	17.155	82.214	4685.8	30.100
298.15	66.612	18.312	84.924	5459.7	31.781

Table 38. BFCl(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	39.812	7.947	47.759	397.3	7.960
75.	43.037	7.966	51.003	597.4	8.074
100.	45.335	8.021	53.356	802.1	8.312
125.	47.134	8.107	55.240	1013.3	8.586
150.	48.621	8.208	56.829	1231.2	8.843
175.	49.894	8.316	58.210	1455.2	9.073
200.	51.011	8.424	59.435	1684.7	9.285
225.	52.010	8.531	60.540	1919.4	9.487
250.	52.914	8.636	61.550	2159.0	9.684
275.	53.742	8.740	62.482	2403.6	9.878
300.	54.507	8.843	63.350	2653.0	10.071
325.	55.219	8.945	64.164	2907.1	10.261
350.	55.885	9.046	64.931	3166.0	10.447
375.	56.513	9.145	65.658	3429.4	10.628
400.	57.106	9.243	66.350	3697.3	10.803
425.	57.670	9.340	67.010	3969.5	10.970
450.	58.206	9.435	67.641	4245.8	11.130
475.	58.719	9.528	68.247	4525.9	11.282
500.	59.210	9.620	68.829	4809.8	11.426
550.	60.135	9.796	69.931	5387.8	11.689
600.	60.995	9.964	70.958	5978.2	11.921
650.	61.798	10.122	71.921	6579.5	12.125
700.	62.554	10.272	72.826	7190.3	12.303
750.	63.268	10.413	73.680	7809.4	12.459
800.	63.944	10.545	74.489	8435.8	12.596
850.	64.587	10.669	75.256	9068.7	12.715
900.	65.200	10.786	75.986	9707.1	12.821
950.	65.786	10.895	76.682	10350.6	12.914
1000.	66.348	10.998	77.346	10998.4	12.996
1050.	66.887	11.095	77.982	11650.0	13.069
1100.	67.405	11.187	78.592	12305.2	13.135
1150.	67.904	11.272	79.177	12963.4	13.193
1200.	68.386	11.354	79.739	13624.3	13.245
1250.	68.851	11.430	80.281	14287.8	13.292
1300.	69.300	11.503	80.803	14953.4	13.334
1350.	69.736	11.571	81.307	15621.1	13.372
1400.	70.158	11.636	81.794	16290.6	13.407
1450.	70.567	11.698	82.265	16961.7	13.438
1500.	70.965	11.756	82.721	17634.4	13.467
1550.	71.351	11.812	83.163	18308.4	13.493
1600.	71.727	11.865	83.592	18983.7	13.517
1650.	72.093	11.915	84.008	19660.1	13.539
1700.	72.449	11.963	84.413	20337.6	13.560
1750.	72.797	12.009	84.806	21016.0	13.578
1800.	73.136	12.053	85.189	21695.4	13.596
1850.	73.467	12.095	85.562	22375.6	13.612
1900.	73.790	12.135	85.925	23056.5	13.626
1950.	74.105	12.173	86.279	23738.2	13.640
2000.	74.414	12.210	86.624	24420.5	13.653
2050.	74.716	12.246	86.962	25103.5	13.665

Table 38. BFCl(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	75.012	12.280	87.291	25787.0	13.676
2150.	75.301	12.312	87.613	26471.1	13.686
2200.	75.584	12.343	87.928	27155.6	13.696
2250.	75.862	12.374	88.236	27840.7	13.705
2300.	76.134	12.403	88.537	28526.2	13.714
2350.	76.401	12.431	88.832	29212.1	13.722
2400.	76.663	12.458	89.121	29898.3	13.729
2450.	76.920	12.484	89.404	30585.0	13.737
2500.	77.173	12.509	89.682	31272.0	13.743
2600.	77.664	12.557	90.221	32646.9	13.756
2700.	78.139	12.601	90.740	34023.1	13.767
2800.	78.598	12.643	91.241	35400.2	13.777
2900.	79.043	12.682	91.725	36778.3	13.785
3000.	79.473	12.719	92.192	38157.3	13.793
3100.	79.891	12.754	92.645	39537.0	13.801
3200.	80.296	12.787	93.083	40917.4	13.807
3300.	80.690	12.818	93.508	42298.5	13.814
3400.	81.073	12.847	93.920	43680.1	13.819
3500.	81.446	12.875	94.321	45062.3	13.824
3600.	81.809	12.901	94.710	46444.9	13.829
3700.	82.163	12.927	95.089	47828.1	13.833
3800.	82.508	12.950	95.458	49211.6	13.837
3900.	82.845	12.973	95.818	50595.5	13.841
4000.	83.173	12.995	96.168	51979.7	13.844
4100.	83.495	13.016	96.510	53364.3	13.847
4200.	83.808	13.036	96.844	54749.2	13.850
4300.	84.115	13.055	97.170	56134.4	13.853
4400.	84.416	13.073	97.488	57519.8	13.856
4500.	84.710	13.090	97.800	58905.5	13.858
4600.	84.998	13.107	98.104	60291.5	13.860
4700.	85.280	13.123	98.403	61677.6	13.862
4800.	85.556	13.138	98.694	63064.0	13.864
4900.	85.827	13.153	98.980	64450.5	13.866
5000.	86.093	13.167	99.260	65837.2	13.868
5100.	86.354	13.181	99.535	67224.1	13.870
5200.	86.610	13.194	99.804	68611.1	13.871
5300.	86.861	13.207	100.069	69998.4	13.873
5400.	87.108	13.220	100.328	71385.7	13.874
5500.	87.351	13.231	100.583	72773.2	13.875
5600.	87.590	13.243	100.833	74160.8	13.877
5700.	87.824	13.254	101.078	75548.5	13.878
5800.	88.055	13.265	101.320	76936.4	13.879
5900.	88.282	13.275	101.557	78324.3	13.880
6000.	88.505	13.285	101.790	79712.4	13.881
273.15	53.683	8.733	62.416	2385.3	9.864
298.15	54.452	8.836	63.288	2634.3	10.057

Table 39. BF_2Cl(gas)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	41.176	7.948	49.124	397.4	7.956
75.	44.401	7.965	52.366	597.4	8.075
100.	46.700	8.032	54.732	803.2	8.428
125.	48.505	8.163	56.668	1020.4	8.971
150.	50.009	8.350	58.359	1252.5	9.607
175.	51.313	8.577	59.890	1500.9	10.265
200.	52.475	8.828	61.302	1765.5	10.903
225.	53.529	9.092	62.621	2045.7	11.503
250.	54.501	9.361	63.863	2340.3	12.060
275.	55.406	9.630	65.037	2648.3	12.575
300.	56.256	9.896	66.151	2968.8	13.052
325.	57.058	10.156	67.214	3300.7	13.494
350.	57.820	10.409	68.229	3643.2	13.904
375.	58.546	10.655	69.201	3995.6	14.284
400.	59.242	10.893	70.135	4357.2	14.638
425.	59.909	11.123	71.032	4727.3	14.965
450.	60.551	11.345	71.896	5105.3	15.270
475.	61.170	11.559	72.729	5490.6	15.552
500.	61.769	11.765	73.534	5882.7	15.814
550.	62.908	12.155	75.064	6685.4	16.281
600.	63.982	12.516	76.498	7509.7	16.683
650.	64.997	12.850	77.847	8352.8	17.029
700.	65.961	13.160	79.120	9211.8	17.327
750.	66.879	13.446	80.325	10084.7	17.584
800.	67.755	13.712	81.467	10969.7	17.807
850.	68.594	13.959	82.553	11865.0	18.002
900.	69.398	14.188	83.586	12769.4	18.171
950.	70.171	14.402	84.573	13681.8	18.320
1000.	70.915	14.601	85.516	14601.2	18.452
1050.	71.632	14.787	86.419	15526.7	18.567
1100.	72.324	14.962	87.285	16457.7	18.670
1150.	72.993	15.125	88.117	17393.5	18.762
1200.	73.640	15.278	88.918	18333.7	18.844
1250.	74.266	15.422	89.688	19277.8	18.917
1300.	74.874	15.558	90.432	20225.3	18.983
1350.	75.463	15.686	91.149	21176.0	19.043
1400.	76.036	15.807	91.843	22129.5	19.097
1450.	76.593	15.921	92.514	23085.6	19.146
1500.	77.134	16.029	93.164	24044.1	19.191
1550.	77.662	16.132	93.794	25004.6	19.231
1600.	78.175	16.229	94.405	25967.1	19.268
1650.	78.676	16.322	94.998	26931.4	19.303
1700.	79.165	16.410	95.575	27897.3	19.334
1750.	79.642	16.494	96.136	28864.8	19.363
1800.	80.107	16.574	96.682	29833.6	19.390
1850.	80.563	16.651	97.213	30803.7	19.414
1900.	81.008	16.724	97.731	31775.0	19.437
1950.	81.443	16.794	98.236	32747.4	19.458
2000.	81.869	16.860	98.729	33720.8	19.478
2050.	82.286	16.924	99.210	34695.1	19.496

Table 39. BF_2Cl(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	82.695	16.986	99.681	35670.4	19.513
2150.	83.095	17.045	100.140	36646.4	19.529
2200.	83.488	17.101	100.589	37623.3	19.544
2250.	83.872	17.156	101.028	38600.9	19.558
2300.	84.250	17.208	101.458	39579.1	19.571
2350.	84.621	17.259	101.879	40558.0	19.584
2400.	84.985	17.307	102.292	41537.5	19.595
2450.	85.342	17.354	102.696	42517.5	19.606
2500.	85.693	17.399	103.092	43498.1	19.617
2600.	86.377	17.485	103.862	45460.7	19.635
2700.	87.038	17.565	104.603	47425.1	19.652
2800.	87.679	17.640	105.318	49391.1	19.668
2900.	88.299	17.710	106.009	51358.6	19.681
3000.	88.900	17.776	106.676	53327.3	19.694
3100.	89.484	17.838	107.322	55297.3	19.705
3200.	90.052	17.896	107.948	57268.2	19.715
3300.	90.603	17.952	108.555	59240.2	19.724
3400.	91.140	18.004	109.144	61213.1	19.733
3500.	91.662	18.053	109.716	63186.7	19.740
3600.	92.172	18.100	110.272	65161.1	19.748
3700.	92.668	18.145	110.813	67136.2	19.754
3800.	93.153	18.187	111.340	69111.9	19.760
3900.	93.626	18.228	111.853	71088.3	19.766
4000.	94.088	18.266	112.354	73065.1	19.771
4100.	94.539	18.303	112.842	75042.5	19.776
4200.	94.981	18.338	113.319	77020.3	19.780
4300.	95.412	18.372	113.784	78998.6	19.785
4400.	95.835	18.404	114.239	80977.2	19.789
4500.	96.249	18.435	114.684	82956.3	19.792
4600.	96.655	18.464	115.119	84935.7	19.796
4700.	97.052	18.493	115.545	86915.4	19.799
4800.	97.442	18.520	115.962	88895.4	19.802
4900.	97.824	18.546	116.370	90875.8	19.805
5000.	98.199	18.571	116.770	92856.4	19.807
5100.	98.567	18.596	117.162	94837.3	19.810
5200.	98.928	18.619	117.547	96818.4	19.812
5300.	99.283	18.641	117.924	98799.7	19.815
5400.	99.632	18.663	118.295	100781.3	19.817
5500.	99.974	18.684	118.658	102763.1	19.819
5600.	100.311	18.704	119.016	104745.0	19.821
5700.	100.642	18.724	119.366	106727.2	19.822
5800.	100.968	18.743	119.711	108709.5	19.824
5900.	101.289	18.761	120.050	110692.0	19.826
6000.	101.604	18.779	120.383	112674.6	19.827
273.15	55.341	9.611	64.952	2625.1	12.538
298.15	56.194	9.876	66.071	2944.6	13.018

Table 40. $BFCl_2$(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	42.507	7.956	50.463	397.8	8.015
75.	45.744	8.031	53.775	602.3	8.407
100.	48.076	8.205	56.281	820.5	9.078
125.	49.933	8.457	58.389	1057.1	9.855
150.	51.500	8.755	60.255	1313.3	10.634
175.	52.874	9.077	61.950	1588.4	11.367
200.	54.107	9.405	63.513	1881.1	12.037
225.	55.234	9.732	64.966	2189.7	12.644
250.	56.276	10.051	66.327	2512.8	13.194
275.	57.249	10.360	67.609	2849.0	13.694
300.	58.163	10.657	68.820	3197.1	14.149
325.	59.027	10.942	69.969	3556.1	14.566
350.	59.848	11.215	71.063	3925.1	14.947
375.	60.631	11.475	72.106	4303.2	15.296
400.	61.379	11.724	73.104	4689.7	15.616
425.	62.097	11.962	74.059	5083.8	15.909
450.	62.788	12.189	74.976	5484.9	16.178
475.	63.452	12.405	75.858	5892.5	16.425
500.	64.094	12.612	76.706	6306.0	16.651
550.	65.314	12.998	78.312	7148.8	17.049
600.	66.461	13.350	79.810	8009.9	17.385
650.	67.542	13.671	81.214	8886.5	17.670
700.	68.566	13.966	82.532	9776.2	17.912
750.	69.539	14.236	83.775	10677.1	18.119
800.	70.466	14.484	84.950	11587.6	18.297
850.	71.351	14.713	86.064	12506.4	18.450
900.	72.198	14.925	87.123	13432.3	18.584
950.	73.010	15.120	88.131	14364.4	18.700
1000.	73.791	15.302	89.093	15302.0	18.801
1050.	74.541	15.471	90.012	16244.4	18.891
1100.	75.265	15.628	90.893	17190.9	18.970
1150.	75.963	15.775	91.738	18141.2	19.040
1200.	76.637	15.912	92.549	19094.8	19.103
1250.	77.289	16.041	93.330	20051.4	19.159
1300.	77.921	16.162	94.083	21010.6	19.209
1350.	78.533	16.276	94.809	21972.2	19.254
1400.	79.127	16.383	95.509	22935.9	19.295
1450.	79.703	16.484	96.187	23901.6	19.332
1500.	80.264	16.579	96.843	24869.0	19.365
1550.	80.809	16.670	97.479	25838.1	19.396
1600.	81.340	16.755	98.095	26808.6	19.424
1650.	81.856	16.837	98.693	27780.4	19.449
1700.	82.360	16.914	99.274	28753.5	19.473
1750.	82.852	16.987	99.839	29727.7	19.495
1800.	83.331	17.057	100.388	30702.9	19.515
1850.	83.799	17.124	100.923	31679.1	19.533
1900.	84.257	17.187	101.444	32656.2	19.550
1950.	84.704	17.248	101.952	33634.1	19.566
2000.	85.142	17.306	102.448	34612.8	19.581
2050.	85.570	17.362	102.932	35592.1	19.594

Table 40. $BFCl_2$(gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	85.989	17.415	103.404	36572.2	19.607
2150.	86.399	17.466	103.865	37552.8	19.619
2200.	86.801	17.515	104.317	38534.0	19.630
2250.	87.195	17.563	104.758	39515.8	19.640
2300.	87.582	17.608	105.190	40498.1	19.650
2350.	87.961	17.651	105.612	41480.8	19.659
2400.	88.333	17.693	106.026	42464.0	19.668
2450.	88.698	17.734	106.432	43447.6	19.676
2500.	89.057	17.773	106.829	44431.6	19.684
2600.	89.755	17.846	107.602	46400.6	19.698
2700.	90.430	17.915	108.345	48371.0	19.710
2800.	91.083	17.980	109.062	50342.6	19.721
2900.	91.715	18.040	109.755	52315.3	19.731
3000.	92.327	18.096	110.424	54288.9	19.741
3100.	92.922	18.149	111.071	56263.4	19.749
3200.	93.499	18.200	111.698	58238.6	19.756
3300.	94.059	18.247	112.306	60214.6	19.763
3400.	94.605	18.292	112.896	62191.3	19.770
3500.	95.136	18.334	113.470	64168.5	19.775
3600.	95.653	18.374	114.027	66146.3	19.781
3700.	96.157	18.412	114.569	68124.6	19.785
3800.	96.648	18.448	115.096	70103.4	19.790
3900.	97.128	18.483	115.611	72082.6	19.794
4000.	97.596	18.516	116.112	74062.2	19.798
4100.	98.054	18.547	116.601	76042.1	19.801
4200.	98.501	18.577	117.078	78022.4	19.805
4300.	98.939	18.605	117.544	80003.1	19.808
4400.	99.367	18.633	117.999	81984.0	19.811
4500.	99.786	18.659	118.445	83965.2	19.813
4600.	100.196	18.684	118.880	85946.7	19.816
4700.	100.598	18.708	119.306	87928.4	19.818
4800.	100.992	18.731	119.724	89910.4	19.821
4900.	101.379	18.754	120.132	91892.5	19.823
5000.	101.758	18.775	120.533	93874.9	19.825
5100.	102.130	18.796	120.925	95857.5	19.827
5200.	102.495	18.815	121.310	97840.2	19.828
5300.	102.853	18.835	121.688	99823.1	19.830
5400.	103.206	18.853	122.059	101806.2	19.831
5500.	103.552	18.871	122.423	103789.4	19.833
5600.	103.892	18.888	122.780	105772.8	19.834
5700.	104.226	18.905	123.131	107756.3	19.836
5800.	104.555	18.921	123.476	109739.9	19.837
5900.	104.879	18.936	123.815	111723.6	19.838
6000.	105.197	18.951	124.149	113707.5	19.839
273.15	57.179	10.338	67.516	2823.7	13.658
298.15	58.097	10.635	68.732	3171.0	14.117

Table 41. BBr(gas)

T	$-(F^\circ-H_0^\circ)/T$	$(H^\circ-H_0^\circ)/T$	S°	$(H^\circ-H_0^\circ)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	34.048	6.947	40.994	347.3	6.957
75.	36.865	6.950	43.815	521.3	6.958
100.	38.865	6.953	45.818	695.3	6.968
125.	40.417	6.959	47.376	869.9	7.006
150.	41.687	6.973	48.660	1045.9	7.083
175.	42.763	6.996	49.759	1224.3	7.192
200.	43.699	7.029	50.728	1405.7	7.322
225.	44.529	7.069	51.598	1590.5	7.460
250.	45.277	7.115	52.391	1778.7	7.597
275.	45.957	7.165	53.122	1970.3	7.726
300.	46.583	7.216	53.799	2164.9	7.845
325.	47.162	7.269	54.431	2362.4	7.954
350.	47.703	7.322	55.024	2562.5	8.051
375.	48.210	7.373	55.583	2764.9	8.138
400.	48.687	7.423	56.111	2969.4	8.216
425.	49.139	7.472	56.611	3175.6	8.285
450.	49.567	7.519	57.086	3383.6	8.347
475.	49.975	7.564	57.539	3592.9	8.402
500.	50.364	7.607	57.971	3803.6	8.452
550.	51.093	7.688	58.781	4228.4	8.536
600.	51.765	7.762	59.527	4657.0	8.605
650.	52.389	7.829	60.218	5088.7	8.663
700.	52.972	7.890	60.862	5523.1	8.710
750.	53.518	7.946	61.464	5959.7	8.751
800.	54.032	7.998	62.030	6398.1	8.786
850.	54.519	8.045	62.564	6838.2	8.816
900.	54.980	8.088	63.068	7279.6	8.843
950.	55.418	8.129	63.547	7722.4	8.866
1000.	55.836	8.166	64.002	8166.2	8.887
1050.	56.235	8.201	64.436	8611.1	8.906
1100.	56.618	8.233	64.851	9056.8	8.924
1150.	56.984	8.264	65.248	9503.4	8.940
1200.	57.337	8.292	65.629	9950.7	8.954
1250.	57.676	8.319	65.995	10398.8	8.968
1300.	58.002	8.344	66.347	10847.5	8.981
1350.	58.318	8.368	66.686	11296.9	8.993
1400.	58.623	8.391	67.013	11746.8	9.004
1450.	58.917	8.412	67.329	12197.3	9.015
1500.	59.203	8.432	67.635	12648.3	9.026
1550.	59.480	8.452	67.931	13099.8	9.036
1600.	59.748	8.470	68.218	13551.9	9.045
1650.	60.009	8.487	68.497	14004.4	9.055
1700.	60.263	8.504	68.767	14457.3	9.064
1750.	60.510	8.520	69.030	14910.7	9.072
1800.	60.750	8.536	69.286	15364.5	9.081
1850.	60.984	8.551	69.535	15818.8	9.089
1900.	61.212	8.565	69.777	16273.5	9.098
1950.	61.435	8.579	70.014	16728.6	9.106
2000.	61.652	8.592	70.244	17184.0	9.114
2050.	61.864	8.605	70.469	17639.9	9.121

Table 41. BBr(gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	62.072	8.617	70.689	18096.2	9.129
2150.	62.275	8.629	70.904	18552.8	9.137
2200.	62.473	8.641	71.114	19009.9	9.144
2250.	62.668	8.652	71.320	19467.3	9.152
2300.	62.858	8.663	71.521	19925.1	9.159
2350.	63.044	8.674	71.718	20383.2	9.167
2400.	63.227	8.684	71.911	20841.7	9.174
2450.	63.406	8.694	72.100	21300.6	9.181
2500.	63.582	8.704	72.286	21759.8	9.189
2600.	63.924	8.723	72.647	22679.4	9.203
2700.	64.253	8.741	72.994	23600.4	9.217
2800.	64.572	8.758	73.330	24522.9	9.232
2900.	64.879	8.775	73.654	25446.8	9.246
3000.	65.177	8.791	73.968	26372.1	9.260
3100.	65.465	8.806	74.271	27298.8	9.274
3200.	65.745	8.821	74.566	28226.9	9.289
3300.	66.017	8.835	74.852	29156.5	9.303
3400.	66.281	8.849	75.130	30087.5	9.317
3500.	66.538	8.863	75.400	31020.0	9.332
3600.	66.787	8.876	75.664	31953.9	9.346
3700.	67.031	8.889	75.920	32889.2	9.361
3800.	67.268	8.902	76.170	33826.1	9.375
3900.	67.499	8.914	76.413	34764.3	9.390
4000.	67.725	8.926	76.651	35704.1	9.405
4100.	67.946	8.938	76.884	36645.3	9.420
4200.	68.161	8.950	77.111	37588.0	9.435
4300.	68.372	8.961	77.333	38532.2	9.450
4400.	68.578	8.972	77.550	39478.0	9.465
4500.	68.780	8.983	77.763	40425.2	9.480
4600.	68.977	8.994	77.972	41374.0	9.495
4700.	69.171	9.005	78.176	42324.3	9.511
4800.	69.361	9.016	78.377	43276.2	9.526
4900.	69.547	9.026	78.573	44229.6	9.542
5000.	69.729	9.037	78.766	45184.6	9.558
5100.	69.908	9.047	78.956	46141.2	9.574
5200.	70.084	9.058	79.142	47099.4	9.590
5300.	70.257	9.068	79.324	48059.2	9.606
5400.	70.426	9.078	79.504	49020.6	9.622
5500.	70.593	9.088	79.681	49983.6	9.638
5600.	70.757	9.098	79.855	50948.3	9.655
5700.	70.918	9.108	80.026	51914.6	9.671
5800.	71.076	9.118	80.194	52882.6	9.688
5900.	71.232	9.127	80.360	53852.2	9.705
6000.	71.386	9.137	80.523	54823.5	9.722
273.15	45.909	7.161	53.070	1956.0	7.717
298.15	46.538	7.213	53.751	2150.4	7.837

Table 42. BBr_3(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	47.092	8.181	55.273	409.1	8.995
75.	50.499	8.683	59.182	651.2	10.362
100.	53.075	9.255	62.330	925.5	11.541
125.	55.201	9.811	65.011	1226.4	12.492
150.	57.035	10.324	67.360	1548.6	13.265
175.	58.662	10.792	69.454	1888.6	13.916
200.	60.132	11.219	71.351	2243.7	14.485
225.	61.476	11.610	73.086	2612.3	14.993
250.	62.718	11.972	74.690	2993.0	15.451
275.	63.875	12.307	76.183	3384.5	15.864
300.	64.960	12.619	77.579	3785.8	16.235
325.	65.981	12.911	78.892	4195.9	16.568
350.	66.948	13.183	80.131	4613.9	16.865
375.	67.867	13.437	81.304	5038.9	17.130
400.	68.741	13.675	82.417	5470.2	17.367
425.	69.577	13.899	83.476	5907.0	17.578
450.	70.378	14.109	84.486	6348.9	17.766
475.	71.146	14.306	85.452	6795.2	17.935
500.	71.884	14.491	86.375	7245.5	18.086
550.	73.282	14.830	88.112	8156.4	18.342
600.	74.585	15.131	89.717	9078.9	18.550
650.	75.807	15.401	91.209	10010.8	18.721
700.	76.958	15.644	92.601	10950.5	18.861
750.	78.045	15.862	93.907	11896.5	18.979
800.	79.075	16.060	95.135	12848.0	19.077
850.	80.054	16.240	96.294	13804.0	19.161
900.	80.987	16.404	97.391	14763.9	19.232
950.	81.878	16.555	98.433	15727.1	19.294
1000.	82.731	16.693	99.424	16693.2	19.347
1050.	83.548	16.821	100.369	17661.7	19.393
1100.	84.333	16.939	101.272	18632.4	19.434
1150.	85.089	17.048	102.137	19605.0	19.469
1200.	85.817	17.149	102.966	20579.3	19.501
1250.	86.519	17.244	103.763	21555.0	19.529
1300.	87.197	17.332	104.529	22532.1	19.554
1350.	87.852	17.415	105.267	23510.4	19.576
1400.	88.487	17.493	105.980	24489.7	19.597
1450.	89.102	17.566	106.668	25470.0	19.615
1500.	89.699	17.634	107.333	26451.2	19.631
1550.	90.278	17.699	107.977	27433.1	19.646
1600.	90.841	17.760	108.601	28415.8	19.660
1650.	91.388	17.818	109.206	29399.1	19.672
1700.	91.921	17.872	109.794	30383.0	19.684
1750.	92.440	17.924	110.364	31367.4	19.694
1800.	92.946	17.974	110.919	32352.4	19.704
1850.	93.439	18.020	111.459	33337.8	19.712
1900.	93.920	18.065	111.985	34323.6	19.721
1950.	94.390	18.108	112.497	35309.9	19.728
2000.	94.849	18.148	112.997	36296.4	19.735
2050.	95.297	18.187	113.484	37283.4	19.742

Table 42. BBr_3(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	95.736	18.224	113.960	38270.6	19.748
2150.	96.165	18.260	114.425	39258.2	19.754
2200.	96.585	18.294	114.879	40246.0	19.759
2250.	96.997	18.326	115.323	41234.0	19.764
2300.	97.400	18.358	115.758	42222.3	19.768
2350.	97.795	18.388	116.183	43210.9	19.773
2400.	98.183	18.416	116.599	44199.6	19.777
2450.	98.563	18.444	117.007	45188.5	19.781
2500.	98.935	18.471	117.407	46177.7	19.784
2600.	99.661	18.522	118.183	48156.4	19.791
2700.	100.361	18.569	118.930	50135.8	19.797
2800.	101.037	18.613	119.650	52115.7	19.802
2900.	101.691	18.654	120.345	54096.2	19.807
3000.	102.324	18.692	121.016	56077.1	19.811
3100.	102.937	18.729	121.666	58058.4	19.815
3200.	103.533	18.763	122.295	60040.0	19.818
3300.	104.110	18.795	122.905	62022.1	19.822
3400.	104.672	18.825	123.497	64004.4	19.825
3500.	105.218	18.853	124.071	65987.0	19.827
3600.	105.750	18.881	124.630	67969.8	19.830
3700.	106.267	18.906	125.173	69952.9	19.832
3800.	106.772	18.931	125.702	71936.2	19.834
3900.	107.264	18.954	126.218	73919.7	19.836
4000.	107.744	18.976	126.720	75903.4	19.838
4100.	108.213	18.997	127.210	77887.3	19.840
4200.	108.671	19.017	127.688	79871.3	19.841
4300.	109.118	19.036	128.155	81855.5	19.843
4400.	109.556	19.055	128.611	83839.8	19.844
4500.	109.985	19.072	129.057	85824.3	19.845
4600.	110.404	19.089	129.493	87808.9	19.846
4700.	110.815	19.105	129.920	89793.6	19.847
4800.	111.217	19.120	130.338	91778.4	19.848
4900.	111.612	19.135	130.747	93763.2	19.849
5000.	111.998	19.150	131.148	95748.2	19.850
5100.	112.378	19.163	131.541	97733.3	19.851
5200.	112.750	19.177	131.927	99718.5	19.852
5300.	113.115	19.189	132.305	101703.7	19.853
5400.	113.474	19.202	132.676	103689.0	19.854
5500.	113.827	19.214	133.040	105674.4	19.854
5600.	114.173	19.225	133.398	107659.9	19.855
5700.	114.513	19.236	133.749	109645.4	19.855
5800.	114.848	19.247	134.095	111631.0	19.856
5900.	115.177	19.257	134.434	113616.6	19.857
6000.	115.501	19.267	134.768	115602.3	19.857
273.15	63.792	12.283	76.076	3355.2	15.835
298.15	64.882	12.597	77.479	3755.8	16.209

Table 43. BF_2Br(gas)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	42.890	7.950	50.840	397.5	7.972
75.	46.118	7.988	54.107	599.1	8.212
100.	48.430	8.106	56.536	810.6	8.742
125.	50.259	8.300	58.559	1037.5	9.423
150.	51.793	8.547	60.340	1282.0	10.140
175.	53.131	8.824	61.956	1544.3	10.832
200.	54.329	9.116	63.445	1823.2	11.474
225.	55.419	9.411	64.831	2117.5	12.060
250.	56.426	9.703	66.129	2425.8	12.593
275.	57.364	9.988	67.353	2746.8	13.080
300.	58.245	10.265	68.510	3079.5	13.526
325.	59.078	10.532	69.609	3422.8	13.938
350.	59.868	10.789	70.656	3776.1	14.319
375.	60.620	11.036	71.657	4138.6	14.672
400.	61.340	11.274	72.614	4509.5	14.999
425.	62.031	11.502	73.533	4888.3	15.303
450.	62.694	11.721	74.415	5274.5	15.585
475.	63.334	11.931	75.265	5667.4	15.847
500.	63.951	12.133	76.084	6066.7	16.090
550.	65.125	12.513	77.639	6882.3	16.525
600.	66.229	12.864	79.093	7718.1	16.898
650.	67.272	13.187	80.459	8571.3	17.220
700.	68.260	13.485	81.745	9439.4	17.497
750.	69.200	13.761	82.961	10320.4	17.737
800.	70.097	14.016	84.112	11212.6	17.945
850.	70.953	14.252	85.206	12114.5	18.126
900.	71.774	14.472	86.246	13024.8	18.285
950.	72.562	14.676	87.239	13942.6	18.424
1000.	73.320	14.867	88.187	14866.9	18.546
1050.	74.050	15.045	89.095	15797.0	18.654
1100.	74.754	15.211	89.965	16732.1	18.750
1150.	75.433	15.367	90.800	17671.8	18.836
1200.	76.090	15.513	91.603	18615.5	18.912
1250.	76.726	15.650	92.377	19562.9	18.980
1300.	77.343	15.780	93.122	20513.5	19.042
1350.	77.941	15.901	93.842	21467.0	19.098
1400.	78.521	16.017	94.537	22423.1	19.148
1450.	79.085	16.125	95.210	23381.7	19.194
1500.	79.633	16.228	95.862	24342.5	19.236
1550.	80.167	16.326	96.493	25305.2	19.274
1600.	80.687	16.419	97.105	26269.8	19.308
1650.	81.193	16.507	97.700	27236.0	19.340
1700.	81.687	16.590	98.278	28203.8	19.370
1750.	82.170	16.670	98.840	29172.9	19.397
1800.	82.640	16.746	99.387	30143.4	19.421
1850.	83.100	16.819	99.919	31115.0	19.444
1900.	83.550	16.888	100.438	32087.8	19.466
1950.	83.989	16.955	100.944	33061.6	19.486
2000.	84.419	17.018	101.437	34036.3	19.504
2050.	84.840	17.079	101.919	35012.0	19.521

Table 43. BF_2Br(gas) [Continued]

T	$-(F°-H°_0)/T$	$(H°-H°_0)/T$	S°	$(H°-H°_0)$	$C°_p$
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	85.252	17.137	102.390	35988.4	19.537
2150.	85.656	17.193	102.850	36965.6	19.552
2200.	86.052	17.247	103.299	37943.6	19.566
2250.	86.440	17.299	103.739	38922.2	19.579
2300.	86.821	17.348	104.170	39901.5	19.591
2350.	87.195	17.396	104.591	40881.3	19.603
2400.	87.561	17.442	105.004	41861.8	19.614
2450.	87.922	17.487	105.408	42842.7	19.624
2500.	88.275	17.530	105.805	43824.1	19.633
2600.	88.964	17.611	106.575	45788.4	19.651
2700.	89.631	17.687	107.317	47754.3	19.667
2800.	90.275	17.758	108.033	49721.7	19.681
2900.	90.899	17.824	108.724	51690.5	19.694
3000.	91.505	17.887	109.391	53660.4	19.705
3100.	92.092	17.946	110.038	55631.5	19.716
3200.	92.663	18.001	110.664	57603.6	19.725
3300.	93.218	18.053	111.271	59576.5	19.734
3400.	93.757	18.103	111.860	61550.3	19.742
3500.	94.283	18.150	112.433	63524.9	19.749
3600.	94.795	18.194	112.989	65500.1	19.756
3700.	95.294	18.237	113.530	67476.0	19.762
3800.	95.781	18.277	114.058	69452.5	19.768
3900.	96.256	18.315	114.571	71429.5	19.773
4000.	96.720	18.352	115.072	73407.1	19.778
4100.	97.174	18.387	115.560	75385.1	19.782
4200.	97.617	18.420	116.037	77363.5	19.787
4300.	98.051	18.452	116.503	79342.4	19.790
4400.	98.475	18.482	116.958	81321.6	19.794
4500.	98.891	18.511	117.402	83301.2	19.798
4600.	99.298	18.539	117.838	85281.1	19.801
4700.	99.697	18.566	118.263	87261.4	19.804
4800.	100.088	18.592	118.680	89241.9	19.807
4900.	100.472	18.617	119.089	91222.7	19.809
5000.	100.848	18.641	119.489	93203.7	19.812
5100.	101.218	18.664	119.881	95185.0	19.814
5200.	101.580	18.686	120.266	97166.5	19.816
5300.	101.936	18.707	120.644	99148.3	19.818
5400.	102.286	18.728	121.014	101130.2	19.820
5500.	102.630	18.748	121.378	103112.3	19.822
5600.	102.968	18.767	121.735	105094.7	19.824
5700.	103.300	18.785	122.086	107077.1	19.826
5800.	103.627	18.803	122.431	109059.8	19.827
5900.	103.949	18.821	122.770	111042.6	19.829
6000.	104.265	18.838	123.103	113025.5	19.830
273.15	57.297	9.968	67.265	2722.6	13.045
298.15	58.182	10.245	68.427	3054.5	13.495

Table 44. $BFBr_2$(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	46.372	8.008	54.379	400.4	8.277
75.	49.653	8.218	57.871	616.3	9.041
100.	52.059	8.535	60.594	853.5	9.938
125.	54.003	8.905	62.908	1113.1	10.823
150.	55.661	9.294	64.954	1394.0	11.637
175.	57.122	9.681	66.804	1694.2	12.361
200.	58.440	10.057	68.497	2011.4	12.999
225.	59.645	10.416	70.061	2343.5	13.563
250.	60.760	10.756	71.516	2689.0	14.066
275.	61.801	11.078	72.878	3046.4	14.516
300.	62.778	11.381	74.159	3414.4	14.923
325.	63.700	11.668	75.369	3792.2	15.293
350.	64.575	11.939	76.514	4178.8	15.628
375.	65.408	12.196	77.603	4573.4	15.934
400.	66.202	12.438	78.641	4975.3	16.214
425.	66.963	12.668	79.631	5383.9	16.469
450.	67.694	12.886	80.579	5798.5	16.702
475.	68.396	13.092	81.488	6218.8	16.915
500.	69.073	13.288	82.361	6644.2	17.111
550.	70.356	13.652	84.008	7508.5	17.454
600.	71.559	13.981	85.540	8388.6	17.743
650.	72.690	14.280	86.970	9282.1	17.987
700.	73.758	14.553	88.311	10186.8	18.195
750.	74.771	14.801	89.572	11101.1	18.373
800.	75.733	15.030	90.763	12023.6	18.525
850.	76.651	15.239	91.890	12953.2	18.656
900.	77.528	15.432	92.960	13889.0	18.770
950.	78.367	15.611	93.977	14830.0	18.870
1000.	79.172	15.776	94.947	15775.7	18.957
1050.	79.945	15.929	95.874	16725.5	19.033
1100.	80.690	16.072	96.761	17678.9	19.101
1150.	81.407	16.205	97.612	18635.5	19.161
1200.	82.099	16.329	98.428	19594.9	19.214
1250.	82.768	16.445	99.214	20556.8	19.262
1300.	83.415	16.555	99.970	21521.0	19.305
1350.	84.042	16.657	100.699	22487.3	19.344
1400.	84.650	16.754	101.403	23455.4	19.379
1450.	85.239	16.845	102.084	24425.1	19.410
1500.	85.812	16.931	102.743	25396.3	19.439
1550.	86.368	17.012	103.380	26368.9	19.465
1600.	86.910	17.089	103.999	27342.8	19.489
1650.	87.437	17.162	104.599	28317.8	19.511
1700.	87.950	17.232	105.182	29293.9	19.531
1750.	88.450	17.298	105.748	30270.9	19.550
1800.	88.939	17.360	106.299	31248.8	19.567
1850.	89.415	17.420	106.835	32227.5	19.582
1900.	89.880	17.477	107.358	33207.0	19.597
1950.	90.335	17.532	107.867	34187.2	19.610
2000.	90.780	17.584	108.364	35168.0	19.623
2050.	91.214	17.634	108.848	36149.5	19.635

Table 44. $BFBr_2$(gas) [Continued]

T	$-\frac{(F^\circ-H_0^\circ)}{T}$	$\frac{(H^\circ-H_0^\circ)}{T}$	S°	$(H^\circ-H_0^\circ)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	91.640	17.682	109.322	37131.5	19.646
2150.	92.057	17.727	109.784	38114.0	19.656
2200.	92.465	17.771	110.236	39097.1	19.665
2250.	92.864	17.814	110.678	40080.5	19.674
2300.	93.256	17.854	111.111	41064.5	19.682
2350.	93.641	17.893	111.534	42048.8	19.690
2400.	94.018	17.931	111.949	43033.5	19.698
2450.	94.388	17.967	112.355	44018.5	19.705
2500.	94.751	18.002	112.753	45003.9	19.711
2600.	95.459	18.068	113.526	46975.6	19.723
2700.	96.142	18.129	114.271	48948.5	19.734
2800.	96.802	18.187	114.989	50922.4	19.743
2900.	97.441	18.240	115.682	52897.1	19.752
3000.	98.060	18.291	116.351	54872.7	19.760
3100.	98.661	18.338	116.999	56849.1	19.767
3200.	99.244	18.383	117.627	58826.1	19.773
3300.	99.810	18.425	118.236	60803.7	19.779
3400.	100.361	18.465	118.826	62781.9	19.784
3500.	100.897	18.503	119.400	64760.6	19.789
3600.	101.418	18.539	119.957	66739.7	19.794
3700.	101.927	18.573	120.500	68719.4	19.798
3800.	102.423	18.605	121.028	70699.4	19.802
3900.	102.906	18.636	121.542	72679.7	19.805
4000.	103.378	18.665	122.044	74660.4	19.809
4100.	103.840	18.693	122.533	76641.5	19.812
4200.	104.291	18.720	123.010	78622.8	19.815
4300.	104.731	18.745	123.476	80604.4	19.817
4400.	105.163	18.770	123.932	82586.2	19.820
4500.	105.585	18.793	124.378	84568.3	19.822
4600.	105.998	18.815	124.813	86550.7	19.824
4700.	106.403	18.837	125.240	88533.2	19.826
4800.	106.800	18.857	125.657	90515.9	19.828
4900.	107.189	18.877	126.066	92498.8	19.830
5000.	107.570	18.896	126.467	94481.9	19.832
5100.	107.945	18.915	126.859	96465.1	19.833
5200.	108.312	18.932	127.244	98448.5	19.835
5300.	108.673	18.949	127.622	100432.1	19.836
5400.	109.027	18.966	127.993	102415.7	19.837
5500.	109.375	18.982	128.357	104399.6	19.839
5600.	109.717	18.997	128.715	106383.5	19.840
5700.	110.054	19.012	129.066	108367.5	19.841
5800.	110.385	19.026	129.411	110351.7	19.842
5900.	110.710	19.040	129.750	112336.0	19.843
6000.	111.030	19.053	130.083	114320.3	19.844
273.15	61.726	11.055	72.781	3019.5	14.485
298.15	62.707	11.360	74.067	3386.9	14.895

Table 45. BCl_2Br(gas)

T	$-\frac{(F^\circ-H_0^\circ)}{T}$	$\frac{(H^\circ-H_0^\circ)}{T}$	S°	$(H^\circ-H_0^\circ)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	45.946	8.002	53.948	400.1	8.281
75.	49.229	8.237	57.466	617.8	9.188
100.	51.647	8.604	60.251	860.4	10.220
125.	53.611	9.026	62.637	1128.2	11.184
150.	55.295	9.458	64.753	1418.7	12.033
175.	56.785	9.880	66.665	1728.9	12.773
200.	58.131	10.283	68.414	2056.6	13.425
225.	59.364	10.665	70.029	2399.6	14.006
250.	60.507	11.026	71.532	2756.4	14.528
275.	61.574	11.366	72.940	3125.6	15.000
300.	62.577	11.687	74.263	3506.0	15.425
325.	63.524	11.989	75.513	3896.5	15.809
350.	64.423	12.275	76.698	4296.1	16.155
375.	65.279	12.544	77.823	4704.0	16.466
400.	66.097	12.798	78.895	5119.2	16.746
425.	66.880	13.038	79.918	5541.0	16.997
450.	67.632	13.264	80.896	5968.8	17.223
475.	68.355	13.478	81.833	6402.0	17.426
500.	69.051	13.680	82.731	6840.0	17.609
550.	70.373	14.052	84.425	7728.6	17.924
600.	71.610	14.386	85.996	8631.4	18.181
650.	72.774	14.686	87.460	9545.9	18.393
700.	73.872	14.957	88.829	10470.1	18.570
750.	74.913	15.203	90.116	11402.4	18.718
800.	75.901	15.427	91.328	12341.6	18.844
850.	76.842	15.631	92.474	13286.5	18.950
900.	77.741	15.818	93.559	14236.3	19.041
950.	78.601	15.990	94.591	15190.4	19.120
1000.	79.425	16.148	95.574	16148.2	19.188
1050.	80.217	16.294	96.511	17109.1	19.248
1100.	80.978	16.430	97.408	18072.8	19.300
1150.	81.711	16.556	98.267	19039.0	19.346
1200.	82.418	16.673	99.091	20007.4	19.387
1250.	83.101	16.782	99.883	20977.7	19.424
1300.	83.761	16.884	100.646	21949.7	19.456
1350.	84.400	16.980	101.381	22923.2	19.485
1400.	85.020	17.070	102.090	23898.1	19.511
1450.	85.620	17.155	102.775	24874.3	19.535
1500.	86.203	17.234	103.437	25851.6	19.556
1550.	86.769	17.310	104.079	26829.9	19.576
1600.	87.320	17.381	104.701	27809.2	19.594
1650.	87.856	17.448	105.304	28789.2	19.610
1700.	88.378	17.512	105.890	29770.1	19.625
1750.	88.886	17.572	106.459	30751.7	19.638
1800.	89.382	17.630	107.012	31733.9	19.651
1850.	89.866	17.685	107.551	32716.8	19.662
1900.	90.338	17.737	108.075	33700.2	19.673
1950.	90.800	17.787	108.586	34684.1	19.683
2000.	91.251	17.834	109.085	35668.4	19.692
2050.	91.692	17.880	109.571	36653.3	19.701

Table 45. BCl_2Br(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	92.123	17.923	110.046	37638.5	19.709
2150.	92.545	17.965	110.510	38624.1	19.716
2200.	92.959	18.005	110.963	39610.1	19.723
2250.	93.364	18.043	111.407	40596.4	19.730
2300.	93.761	18.080	111.840	41583.1	19.736
2350.	94.150	18.115	112.265	42570.0	19.741
2400.	94.532	18.149	112.680	43557.2	19.747
2450.	94.906	18.181	113.088	44544.6	19.752
2500.	95.274	18.213	113.487	45532.4	19.756
2600.	95.989	18.272	114.262	47508.4	19.765
2700.	96.680	18.328	115.008	49485.3	19.773
2800.	97.347	18.380	115.727	51463.0	19.780
2900.	97.993	18.428	116.421	53441.3	19.786
3000.	98.619	18.473	117.092	55420.2	19.792
3100.	99.225	18.516	117.741	57399.6	19.797
3200.	99.814	18.556	118.370	59379.5	19.801
3300.	100.385	18.594	118.979	61359.8	19.806
3400.	100.941	18.630	119.570	63340.6	19.809
3500.	101.481	18.663	120.145	65321.7	19.813
3600.	102.008	18.695	120.703	67303.2	19.816
3700.	102.520	18.726	121.246	69284.9	19.819
3800.	103.020	18.754	121.774	71267.0	19.822
3900.	103.508	18.782	122.289	73249.3	19.825
4000.	103.983	18.808	122.791	75231.9	19.827
4100.	104.448	18.833	123.281	77214.7	19.829
4200.	104.902	18.857	123.759	79197.7	19.831
4300.	105.346	18.879	124.225	81180.9	19.833
4400.	105.780	18.901	124.681	83164.3	19.835
4500.	106.205	18.922	125.127	85147.9	19.836
4600.	106.622	18.942	125.563	87131.6	19.838
4700.	107.029	18.961	125.990	89115.5	19.839
4800.	107.429	18.979	126.408	91099.5	19.841
4900.	107.820	18.997	126.817	93083.6	19.842
5000.	108.204	19.014	127.218	95067.9	19.843
5100.	108.581	19.030	127.611	97052.3	19.844
5200.	108.950	19.046	127.996	99036.8	19.846
5300.	109.313	19.061	128.374	101021.4	19.847
5400.	109.670	19.075	128.745	103006.1	19.847
5500.	110.020	19.089	129.109	104990.9	19.848
5600.	110.364	19.103	129.467	106975.8	19.849
5700.	110.702	19.116	129.818	108960.7	19.850
5800.	111.035	19.129	130.163	110945.8	19.851
5900.	111.362	19.141	130.503	112930.9	19.852
6000.	111.684	19.153	130.836	114916.1	19.852
273.15	61.497	11.341	72.838	3097.9	14.966
298.15	62.504	11.664	74.168	3477.5	15.395

Table 46. $BClBr_2$(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	47.682	8.073	55.755	403.7	8.587
75.	51.017	8.431	59.448	632.3	9.726
100.	53.505	8.896	62.401	889.6	10.838
125.	55.542	9.384	64.926	1173.0	11.807
150.	57.295	9.858	67.154	1478.7	12.628
175.	58.849	10.305	69.154	1803.4	13.329
200.	60.253	10.722	70.975	2144.4	13.941
225.	61.538	11.111	72.649	2499.9	14.487
250.	62.728	11.473	74.201	2868.3	14.976
275.	63.837	11.812	75.650	3248.3	15.418
300.	64.879	12.129	77.008	3638.8	15.816
325.	65.862	12.427	78.289	4038.8	16.174
350.	66.793	12.706	79.499	4447.3	16.496
375.	67.679	12.969	80.648	4863.3	16.785
400.	68.524	13.216	81.739	5286.3	17.043
425.	69.332	13.448	82.780	5715.3	17.275
450.	70.107	13.666	83.773	6149.8	17.482
475.	70.851	13.872	84.723	6589.2	17.669
500.	71.568	14.066	85.634	7033.1	17.836
550.	72.925	14.422	87.348	7932.3	18.123
600.	74.194	14.741	88.935	8844.5	18.357
650.	75.386	15.027	90.412	9767.3	18.549
700.	76.509	15.284	91.793	10698.8	18.708
750.	77.571	15.517	93.088	11637.7	18.842
800.	78.580	15.728	94.308	12582.7	18.955
850.	79.539	15.921	95.460	13532.9	19.050
900.	80.454	16.097	96.551	14487.5	19.132
950.	81.329	16.259	97.588	15445.9	19.202
1000.	82.167	16.408	98.574	16407.6	19.264
1050.	82.971	16.545	99.515	17372.1	19.317
1100.	83.743	16.672	100.415	18339.1	19.364
1150.	84.487	16.790	101.277	19308.4	19.405
1200.	85.204	16.900	102.103	20279.5	19.441
1250.	85.896	17.002	102.898	21252.4	19.474
1300.	86.565	17.098	103.662	22226.8	19.502
1350.	87.211	17.187	104.399	23202.6	19.528
1400.	87.838	17.271	105.109	24179.6	19.552
1450.	88.446	17.350	105.796	25157.7	19.573
1500.	89.035	17.425	106.460	26136.9	19.592
1550.	89.608	17.495	107.102	27116.9	19.609
1600.	90.164	17.561	107.725	28097.8	19.625
1650.	90.705	17.624	108.329	29079.4	19.639
1700.	91.232	17.683	108.916	30061.7	19.653
1750.	91.746	17.740	109.486	31044.6	19.665
1800.	92.246	17.793	110.040	32028.1	19.676
1850.	92.735	17.844	110.579	33012.2	19.686
1900.	93.211	17.893	111.104	33996.7	19.696
1950.	93.676	17.939	111.616	34981.7	19.704
2000.	94.131	17.984	112.115	35967.2	19.713
2050.	94.576	18.026	112.602	36953.0	19.720

Table 46. $BClBr_2$(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	95.011	18.066	113.077	37939.2	19.727
2150.	95.436	18.105	113.541	38925.7	19.734
2200.	95.853	18.142	113.995	39912.6	19.740
2250.	96.261	18.178	114.439	40899.7	19.746
2300.	96.661	18.212	114.873	41887.1	19.751
2350.	97.053	18.245	115.297	42874.8	19.756
2400.	97.437	18.276	115.713	43862.7	19.761
2450.	97.814	18.306	116.121	44850.9	19.765
2500.	98.185	18.336	116.520	45839.3	19.770
2600.	98.905	18.391	117.296	47816.6	19.777
2700.	99.600	18.442	118.042	49794.7	19.784
2800.	100.271	18.491	118.762	51773.4	19.790
2900.	100.921	18.535	119.457	53752.7	19.796
3000.	101.550	18.578	120.128	55732.6	19.801
3100.	102.160	18.617	120.777	57712.9	19.805
3200.	102.752	18.654	121.406	59693.6	19.809
3300.	103.326	18.689	122.016	61674.8	19.813
3400.	103.885	18.722	122.607	63656.3	19.817
3500.	104.428	18.754	123.182	65638.1	19.820
3600.	104.957	18.783	123.740	67620.2	19.823
3700.	105.472	18.812	124.283	69602.6	19.825
3800.	105.974	18.838	124.812	71585.3	19.828
3900.	106.463	18.864	125.327	73568.1	19.830
4000.	106.941	18.888	125.829	75551.3	19.832
4100.	107.408	18.911	126.319	77534.6	19.834
4200.	107.864	18.933	126.797	79518.1	19.836
4300.	108.310	18.954	127.263	81501.7	19.838
4400.	108.746	18.974	127.720	83485.6	19.839
4500.	109.172	18.993	128.165	85469.5	19.841
4600.	109.590	19.012	128.602	87453.7	19.842
4700.	109.999	19.029	129.028	89437.9	19.843
4800.	110.400	19.046	129.446	91422.3	19.844
4900.	110.793	19.063	129.855	93406.8	19.846
5000.	111.178	19.078	130.256	95391.4	19.847
5100.	111.556	19.093	130.649	97376.1	19.848
5200.	111.927	19.108	131.035	99360.9	19.849
5300.	112.291	19.122	131.413	101345.8	19.849
5400.	112.648	19.135	131.784	103330.8	19.850
5500.	113.000	19.148	132.148	105315.9	19.851
5600.	113.345	19.161	132.506	107301.1	19.852
5700.	113.684	19.173	132.857	109286.3	19.853
5800.	114.018	19.185	133.202	111271.6	19.853
5900.	114.346	19.196	133.542	113257.0	19.854
6000.	114.668	19.207	133.875	115242.4	19.855
273.15	63.758	11.788	75.546	3219.8	15.387
298.15	64.804	12.107	76.911	3609.6	15.788

Table 47. BI_3(gas)

T	$-\frac{(F°-H°_0)}{T}$	$\frac{(H°-H°_0)}{T}$	S°	$(H°-H°_0)$	$C°_p$
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	50.956	8.678	59.634	433.9	10.292
75.	54.627	9.475	64.102	710.6	11.754
100.	57.452	10.181	67.633	1018.1	12.788
125.	59.790	10.784	70.575	1348.0	13.578
150.	61.804	11.306	73.110	1695.9	14.234
175.	63.582	11.766	75.348	2059.1	14.812
200.	65.180	12.180	77.361	2436.0	15.334
225.	66.637	12.557	79.194	2825.4	15.807
250.	67.978	12.904	80.882	3225.9	16.231
275.	69.223	13.224	82.447	3636.5	16.608
300.	70.387	13.520	83.907	4056.0	16.942
325.	71.480	13.795	85.275	4483.3	17.237
350.	72.512	14.050	86.562	4917.5	17.495
375.	73.489	14.287	87.777	5357.8	17.722
400.	74.419	14.508	88.927	5803.4	17.922
425.	75.304	14.715	90.019	6253.7	18.097
450.	76.151	14.907	91.058	6708.1	18.252
475.	76.962	15.087	92.048	7166.1	18.389
500.	77.740	15.255	92.995	7627.4	18.510
550.	79.209	15.560	94.769	8558.2	18.715
600.	80.574	15.830	96.405	9498.2	18.878
650.	81.851	16.070	97.921	10445.5	19.011
700.	83.050	16.284	99.334	11398.9	19.119
750.	84.180	16.476	100.656	12357.1	19.209
800.	85.249	16.649	101.899	13319.5	19.284
850.	86.263	16.806	103.070	14285.3	19.347
900.	87.228	16.949	104.177	15254.0	19.400
950.	88.148	17.079	105.227	16225.2	19.446
1000.	89.027	17.199	106.226	17198.5	19.486
1050.	89.869	17.308	107.177	18173.7	19.521
1100.	90.676	17.410	108.086	19150.5	19.551
1150.	91.452	17.503	108.956	20128.7	19.577
1200.	92.199	17.590	109.789	21108.2	19.601
1250.	92.919	17.671	110.590	22088.8	19.621
1300.	93.613	17.746	111.360	23070.3	19.640
1350.	94.285	17.817	112.101	24052.7	19.656
1400.	94.934	17.883	112.816	25035.9	19.671
1450.	95.562	17.945	113.507	26019.8	19.684
1500.	96.172	18.003	114.175	27004.3	19.697
1550.	96.763	18.058	114.821	27989.4	19.707
1600.	97.337	18.109	115.446	28975.0	19.717
1650.	97.895	18.158	116.053	29961.1	19.727
1700.	98.438	18.205	116.642	30947.7	19.735
1750.	98.966	18.248	117.215	31934.6	19.743
1800.	99.481	18.290	117.771	32921.9	19.750
1850.	99.982	18.329	118.312	33909.6	19.756
1900.	100.472	18.367	118.839	34897.5	19.762
1950.	100.949	18.403	119.352	35885.8	19.768
2000.	101.416	18.437	119.853	36874.3	19.773
2050.	101.871	18.470	120.341	37863.0	19.777

Table 47. BI_3(gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	102.317	18.501	120.818	38852.0	19.782
2150.	102.753	18.531	121.283	39841.2	19.786
2200.	103.179	18.559	121.738	40830.6	19.790
2250.	103.596	18.587	122.183	41820.2	19.793
2300.	104.005	18.613	122.618	42809.9	19.797
2350.	104.406	18.638	123.044	43799.9	19.800
2400.	104.798	18.662	123.461	44789.9	19.803
2450.	105.183	18.686	123.869	45780.2	19.806
2500.	105.561	18.708	124.269	46770.5	19.808
2600.	106.296	18.751	125.046	48751.6	19.813
2700.	107.004	18.790	125.794	50733.1	19.817
2800.	107.688	18.827	126.515	52715.1	19.821
2900.	108.349	18.861	127.211	54697.4	19.825
3000.	108.989	18.893	127.883	56680.0	19.828
3100.	109.609	18.924	128.533	58663.0	19.831
3200.	110.211	18.952	129.163	60646.2	19.833
3300.	110.794	18.979	129.773	62629.6	19.836
3400.	111.361	19.004	130.365	64613.3	19.838
3500.	111.912	19.028	130.940	66597.2	19.840
3600.	112.449	19.050	131.499	68581.2	19.842
3700.	112.971	19.072	132.043	70565.5	19.843
3800.	113.480	19.092	132.572	72549.9	19.845
3900.	113.976	19.111	133.087	74534.4	19.846
4000.	114.460	19.130	133.590	76519.1	19.847
4100.	114.933	19.147	134.080	78503.9	19.849
4200.	115.394	19.164	134.558	80488.8	19.850
4300.	115.845	19.180	135.025	82473.8	19.851
4400.	116.287	19.195	135.482	84459.0	19.852
4500.	116.718	19.210	135.928	86444.2	19.853
4600.	117.140	19.224	136.364	88429.5	19.854
4700.	117.554	19.237	136.791	90414.9	19.854
4800.	117.959	19.250	137.209	92400.4	19.855
4900.	118.356	19.262	137.619	94385.9	19.856
5000.	118.745	19.274	138.020	96371.5	19.856
5100.	119.127	19.286	138.413	98357.2	19.857
5200.	119.502	19.297	138.799	100342.9	19.858
5300.	119.870	19.307	139.177	102328.7	19.858
5400.	120.231	19.318	139.548	104314.6	19.859
5500.	120.585	19.327	139.912	106300.5	19.859
5600.	120.933	19.337	140.270	108286.4	19.860
5700.	121.276	19.346	140.622	110272.4	19.860
5800.	121.612	19.355	140.967	112258.5	19.861
5900.	121.943	19.363	141.307	114244.5	19.861
6000.	122.269	19.372	141.641	116230.7	19.861
273.15	69.134	13.201	82.335	3605.8	16.582
298.15	70.303	13.499	83.802	4024.7	16.919

Table 48. BS(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	32.240	6.940	39.180	347.0	6.956
75.	35.055	6.946	42.001	520.9	6.956
100.	37.053	6.948	44.002	694.8	6.957
125.	38.604	6.950	45.554	868.8	6.957
150.	39.871	6.952	46.823	1042.7	6.961
175.	40.943	6.953	47.897	1216.8	6.970
200.	41.872	6.956	48.828	1391.3	6.989
225.	42.691	6.962	49.653	1566.4	7.020
250.	43.425	6.970	50.395	1742.4	7.065
275.	44.090	6.981	51.071	1919.7	7.122
300.	44.698	6.995	51.693	2098.6	7.188
325.	45.259	7.013	52.272	2279.2	7.262
350.	45.779	7.033	52.813	2461.7	7.340
375.	46.265	7.057	53.322	2646.2	7.420
400.	46.721	7.082	53.803	2832.7	7.500
425.	47.152	7.109	54.260	3021.2	7.579
450.	47.559	7.137	54.696	3211.7	7.656
475.	47.945	7.166	55.112	3404.0	7.730
500.	48.314	7.196	55.510	3598.1	7.800
550.	49.002	7.257	56.260	3991.5	7.930
600.	49.636	7.318	56.955	4390.9	8.045
650.	50.225	7.378	57.603	4795.8	8.147
700.	50.773	7.436	58.210	5205.3	8.235
750.	51.288	7.492	58.781	5619.1	8.313
800.	51.774	7.546	59.319	6036.5	8.381
850.	52.233	7.596	59.829	6457.0	8.440
900.	52.668	7.645	60.313	6880.4	8.493
950.	53.083	7.691	60.774	7306.2	8.540
1000.	53.478	7.734	61.213	7734.3	8.582
1050.	53.857	7.776	61.632	8164.3	8.619
1100.	54.219	7.815	62.034	8596.1	8.652
1150.	54.568	7.852	62.419	9029.5	8.682
1200.	54.903	7.887	62.789	9464.3	8.709
1250.	55.225	7.920	63.146	9900.4	8.734
1300.	55.536	7.952	63.489	10337.6	8.757
1350.	55.837	7.982	63.819	10776.0	8.777
1400.	56.128	8.011	64.139	11215.3	8.796
1450.	56.410	8.038	64.448	11655.6	8.814
1500.	56.683	8.064	64.747	12096.7	8.830
1550.	56.947	8.089	65.037	12538.6	8.845
1600.	57.205	8.113	65.318	12981.2	8.859
1650.	57.455	8.136	65.591	13424.5	8.873
1700.	57.698	8.158	65.856	13868.4	8.885
1750.	57.935	8.179	66.113	14313.0	8.897
1800.	58.165	8.199	66.364	14758.1	8.908
1850.	58.390	8.218	66.608	15203.7	8.918
1900.	58.610	8.237	66.846	15649.9	8.928
1950.	58.824	8.255	67.078	16096.5	8.938
2000.	59.033	8.272	67.305	16543.6	8.947
2050.	59.237	8.288	67.526	16991.2	8.955

Table 48. BS(gas) [Continued]

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	59.437	8.304	67.742	17439.1	8.964
2150.	59.633	8.320	67.953	17887.5	8.972
2200.	59.824	8.335	68.159	18336.3	8.979
2250.	60.012	8.349	68.361	18785.4	8.987
2300.	60.196	8.363	68.559	19234.9	8.994
2350.	60.376	8.377	68.752	19684.8	9.001
2400.	60.552	8.390	68.942	20135.0	9.007
2450.	60.725	8.402	69.127	20585.6	9.014
2500.	60.895	8.415	69.310	21036.4	9.020
2600.	61.225	8.438	69.664	21939.1	9.033
2700.	61.544	8.460	70.005	22842.9	9.044
2800.	61.852	8.481	70.334	23747.9	9.056
2900.	62.150	8.501	70.652	24654.1	9.067
3000.	62.439	8.520	70.959	25561.3	9.077
3100.	62.719	8.539	71.257	26469.5	9.087
3200.	62.990	8.556	71.546	27378.7	9.097
3300.	63.254	8.572	71.826	28289.0	9.107
3400.	63.510	8.588	72.098	29200.2	9.117
3500.	63.759	8.604	72.362	30112.3	9.126
3600.	64.001	8.618	72.620	31025.4	9.136
3700.	64.238	8.632	72.870	31939.4	9.145
3800.	64.468	8.646	73.114	32854.4	9.154
3900.	64.693	8.659	73.352	33770.2	9.163
4000.	64.912	8.672	73.584	34686.9	9.172
4100.	65.127	8.684	73.811	35604.5	9.181
4200.	65.336	8.696	74.032	36523.0	9.189
4300.	65.541	8.708	74.248	37442.4	9.198
4400.	65.741	8.719	74.460	38362.6	9.207
4500.	65.937	8.730	74.667	39283.8	9.215
4600.	66.129	8.740	74.869	40205.7	9.224
4700.	66.317	8.751	75.068	41128.6	9.233
4800.	66.502	8.761	75.262	42052.3	9.241
4900.	66.682	8.771	75.453	42976.9	9.250
5000.	66.860	8.780	75.640	43902.3	9.259
5100.	67.034	8.790	75.823	44828.6	9.267
5200.	67.204	8.799	76.003	45755.7	9.276
5300.	67.372	8.808	76.180	46683.8	9.285
5400.	67.537	8.817	76.354	47612.7	9.293
5500.	67.699	8.826	76.524	48542.4	9.302
5600.	67.858	8.834	76.692	49473.0	9.310
5700.	68.014	8.843	76.857	50404.5	9.319
5800.	68.168	8.851	77.019	51336.9	9.328
5900.	68.319	8.859	77.179	52270.1	9.337
6000.	68.468	8.867	77.336	53204.2	9.345
273.15	44.043	6.980	51.023	1906.6	7.117
298.15	44.655	6.994	51.649	2085.3	7.183

Table 49. BN(crystal)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
0.	0.0	0.0	0.0	0.0	0.0
50.	0.071	0.132	0.203	0.396	6.6
100.	0.264	0.483	0.747	1.280	48.3
150.	0.535	0.883	1.418	2.096	132.4
200.	0.846	1.297	2.143	2.994	259.4
250.	1.182	1.728	2.910	3.904	432.0
300.	1.536	2.166	3.702	4.815	649.8
350.	1.90	2.60	4.50	5.59	910.
400.	2.28	3.02	5.30	6.28	1208.
450.	2.65	3.42	6.07	6.89	1539.
500.	3.04	3.79	6.83	7.44	1895.
600.	3.79	4.48	8.27	8.41	2688.
700.	4.53	5.10	9.63	9.19	3570.
800.	5.25	5.65	10.90	9.80	4520.
900.	5.94	6.14	12.08	10.28	5526.
1000.	6.61	6.57	13.18	10.66	6570.
1100.	7.25	6.96	14.21	10.96	7656.
1200.	7.87	7.30	15.17	11.20	8760.
1300.	8.47	7.61	16.08	11.38	9893.
1400.	9.05	7.88	16.93	11.52	11032.
1500.	9.60	8.13	17.73	11.63	12195.
1600.	10.13	8.35	18.48	11.71	13360.
1700.	10.64	8.55	19.19	11.77	14535.
1800.	11.14	8.73	19.87	11.82	15714.
1900.	11.62	8.89	20.51	11.86	16891.
2000.	12.08	9.04	21.12	11.90	18080.
2100.	12.52	9.18	21.70	11.9	19278.
2200.	12.95	9.31	22.26	12.0	20482.
2300.	13.37	9.42	22.79	12.0	21666.
2400.	13.77	9.53	23.30	12.0	22872.
2500.	14.16	9.63	23.79	12.1	24075.
2600.	14.54	9.72	24.26	12.1	25272.
2700.	14.91	9.81	24.72	12.1	26487.
2800.	15.26	9.90	25.16	12.1	27720.
2900.	15.62	9.97	25.59	12.1	28913.
3000.	15.96	10.04	26.00	12.2	30120.
3100.	16.30	10.10	26.40	12.2	31310.
3200.	16.63	10.16	26.79	12.2	32512.
3300.	16.94	10.23	27.17	12.3	33759.
273.15	1.344	1.930	3.274	4.326	527.2
298.15	1.523	2.150	3.673	4.783	641.0

Table 50. BN(gas)

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C_p°
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	31.352	6.924	38.276	346.2	6.956
75.	34.162	6.935	41.097	520.1	6.957
100.	36.158	6.940	43.098	694.0	6.957
125.	37.707	6.944	44.651	868.0	6.957
150.	38.973	6.946	45.919	1041.9	6.958
175.	40.044	6.948	46.992	1215.9	6.960
200.	40.972	6.950	47.922	1389.9	6.964
225.	41.791	6.951	48.742	1564.1	6.972
250.	42.523	6.954	49.477	1738.6	6.987
275.	43.186	6.958	50.144	1913.5	7.009
300.	43.792	6.964	50.755	2089.1	7.040
325.	44.349	6.971	51.320	2265.5	7.078
350.	44.866	6.980	51.847	2443.0	7.124
375.	45.348	6.991	52.340	2621.8	7.176
400.	45.800	7.005	52.805	2801.9	7.233
425.	46.225	7.020	53.245	2983.5	7.293
450.	46.627	7.037	53.664	3166.6	7.356
475.	47.008	7.055	54.063	3351.3	7.419
500.	47.370	7.075	54.445	3537.5	7.483
550.	48.046	7.118	55.164	3914.8	7.609
600.	48.668	7.164	55.832	4298.3	7.729
650.	49.243	7.212	56.455	4687.6	7.840
700.	49.779	7.260	57.040	5082.2	7.943
750.	50.282	7.309	57.591	5481.7	8.037
800.	50.755	7.357	58.112	5885.7	8.122
850.	51.203	7.404	58.607	6293.8	8.199
900.	51.627	7.451	59.078	6705.5	8.268
950.	52.031	7.495	59.526	7120.5	8.331
1000.	52.417	7.538	59.955	7538.4	8.387
1050.	52.785	7.580	60.366	7959.1	8.439
1100.	53.139	7.620	60.759	8382.2	8.486
1150.	53.479	7.659	61.137	8807.6	8.528
1200.	53.805	7.696	61.501	9235.0	8.567
1250.	54.120	7.731	61.852	9664.2	8.603
1300.	54.424	7.766	62.190	10095.2	8.635
1350.	54.718	7.798	62.516	10527.7	8.666
1400.	55.002	7.830	62.832	10961.7	8.694
1450.	55.277	7.860	63.137	11397.1	8.719
1500.	55.544	7.889	63.433	11833.6	8.743
1550.	55.803	7.917	63.720	12271.4	8.766
1600.	56.055	7.944	63.999	12710.2	8.787
1650.	56.300	7.970	64.270	13150.0	8.807
1700.	56.538	7.995	64.533	13590.8	8.825
1750.	56.770	8.019	64.789	14032.5	8.842
1800.	56.997	8.042	65.038	14475.1	8.859
1850.	57.217	8.064	65.281	14918.4	8.875
1900.	57.433	8.086	65.518	15362.5	8.889
1950.	57.643	8.106	65.749	15807.3	8.904
2000.	57.848	8.126	65.975	16252.9	8.917
2050.	58.049	8.146	66.195	16699.0	8.930

Table 50. BN(gas) [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	58.246	8.165	66.411	17145.8	8.942
2150.	58.438	8.183	66.621	17593.3	8.954
2200.	58.626	8.201	66.827	18041.3	8.966
2250.	58.811	8.218	67.029	18489.8	8.977
2300.	58.992	8.234	67.226	18938.9	8.987
2350.	59.169	8.250	67.419	19388.6	8.998
2400.	59.343	8.266	67.609	19838.7	9.008
2450.	59.514	8.281	67.795	20289.3	9.017
2500.	59.681	8.296	67.977	20740.4	9.027
2600.	60.007	8.325	68.332	21644.0	9.045
2700.	60.322	8.352	68.673	22549.4	9.062
2800.	60.626	8.377	69.003	23456.4	9.079
2900.	60.920	8.402	69.322	24365.1	9.095
3000.	61.205	8.425	69.631	25275.4	9.110
3100.	61.482	8.447	69.930	26187.1	9.125
3200.	61.751	8.469	70.219	27100.4	9.140
3300.	62.011	8.489	70.501	28015.1	9.154
3400.	62.265	8.509	70.774	28931.1	9.168
3500.	62.512	8.528	71.040	29848.6	9.181
3600.	62.753	8.547	71.299	30767.4	9.195
3700.	62.987	8.564	71.551	31687.6	9.208
3800.	63.216	8.581	71.797	32609.1	9.221
3900.	63.439	8.598	72.037	33531.8	9.234
4000.	63.657	8.614	72.271	34455.9	9.247
4100.	63.870	8.630	72.499	35381.3	9.260
4200.	64.078	8.645	72.722	36307.9	9.273
4300.	64.281	8.659	72.941	37235.8	9.285
4400.	64.481	8.674	73.154	38164.9	9.298
4500.	64.676	8.688	73.363	39095.3	9.310
4600.	64.867	8.702	73.568	40026.9	9.323
4700.	65.054	8.715	73.769	40959.8	9.335
4800.	65.238	8.728	73.966	41893.9	9.348
4900.	65.418	8.741	74.158	42829.3	9.360
5000.	65.594	8.753	74.348	43765.9	9.372
5100.	65.768	8.765	74.533	44703.8	9.385
5200.	65.938	8.777	74.716	45642.9	9.397
5300.	66.106	8.789	74.895	46583.2	9.410
5400.	66.270	8.801	75.071	47524.8	9.422
5500.	66.432	8.812	75.244	48467.6	9.435
5600.	66.590	8.824	75.414	49411.7	9.447
5700.	66.747	8.835	75.581	50357.1	9.460
5800.	66.900	8.845	75.746	51303.7	9.472
5900.	67.052	8.856	75.908	52251.5	9.485
6000.	67.201	8.867	76.067	53200.6	9.498
273.15	43.139	6.958	50.097	1900.5	7.007
298.15	43.749	6.963	50.712	2076.0	7.037

Table 51. $B_3N_3H_2$(gas) Borazine

T	$-\frac{(F°-H°_0)}{T}$	$\frac{(H°-H°_0)}{T}$	S°	$(H°-H°_0)$	$C_p°$
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
50.	39.293	7.956	47.248	397.8	8.020
75.	42.531	8.043	50.574	603.2	8.501
100.	44.872	8.264	53.136	826.4	9.414
125.	46.751	8.611	55.362	1076.4	10.626
150.	48.360	9.065	57.424	1359.7	12.078
175.	49.797	9.611	59.408	1682.0	13.736
200.	51.120	10.239	61.360	2047.8	15.551
225.	52.366	10.935	63.301	2460.4	17.467
250.	53.557	11.686	65.243	2921.5	19.428
275.	54.707	12.479	67.187	3431.8	21.389
300.	55.828	13.302	69.131	3990.7	23.316
325.	56.926	14.145	71.071	4597.1	25.184
350.	58.006	14.998	73.003	5249.3	26.977
375.	59.070	15.854	74.924	5945.3	28.689
400.	60.120	16.707	76.827	6683.0	30.314
425.	61.158	17.554	78.712	7460.3	31.853
450.	62.185	18.389	80.574	8274.9	33.308
475.	63.202	19.211	82.412	9125.0	34.682
500.	64.208	20.017	84.224	10008.4	35.980
550.	66.189	21.578	87.768	11868.1	38.364
600.	68.131	23.068	91.199	13840.6	40.497
650.	70.034	24.484	94.517	15914.3	42.415
700.	71.898	25.827	97.725	18079.1	44.147
750.	73.724	27.102	100.826	20326.3	45.718
800.	75.512	28.311	103.822	22648.5	47.149
850.	77.263	29.458	106.721	25039.1	48.455
900.	78.978	30.547	109.525	27492.2	49.653
950.	80.657	31.582	112.239	30002.8	50.752
1000.	82.302	32.566	114.868	32566.0	51.765
1050.	83.914	33.503	117.417	35177.9	52.698
1100.	85.493	34.395	119.889	37834.6	53.559
1150.	87.041	35.246	122.287	40532.8	54.356
1200.	88.559	36.058	124.616	43269.2	55.094
1250.	90.046	36.833	126.879	46041.2	55.777
1300.	91.506	37.574	129.080	48846.1	56.412
1350.	92.937	38.283	131.220	51681.6	57.001
1400.	94.342	38.961	133.303	54545.5	57.549
1450.	95.720	39.611	135.331	57435.9	58.059
1500.	97.074	40.234	137.308	60350.9	58.534
1550.	98.403	40.831	139.234	63288.8	58.978
1600.	99.708	41.405	141.113	66248.1	59.392
1650.	100.991	41.956	142.947	69227.5	59.779
1700.	102.251	42.486	144.737	72225.6	60.141
1750.	103.490	42.995	146.485	75241.2	60.480
1800.	104.708	43.485	148.193	78273.2	60.797
1850.	105.906	43.957	149.863	81320.6	61.096
1900.	107.085	44.412	151.496	84382.4	61.376
1950.	108.244	44.850	153.094	87457.8	61.639
2000.	109.385	45.273	154.658	90546.0	61.887
2050.	110.508	45.681	156.189	93646.3	62.120

Table 51. $B_3N_3H_2$(gas) Borazine [Continued]

T	$-\frac{(F^\circ-H^\circ_0)}{T}$	$\frac{(H^\circ-H^\circ_0)}{T}$	S°	$(H^\circ-H^\circ_0)$	C°_p
°K	cal/°mole	cal/°mole	cal/°mole	cal/mole	cal/°mole
2100.	111.613	46.075	157.688	96757.8	62.340
2150.	112.702	46.456	159.158	99880.0	62.547
2200.	113.774	46.824	160.598	103012.3	62.743
2250.	114.830	47.180	162.010	106154.2	62.929
2300.	115.871	47.524	163.395	109305.0	63.104
2350.	116.897	47.857	164.754	112464.4	63.270
2400.	117.908	48.180	166.088	115631.8	63.427
2450.	118.904	48.493	167.397	118806.9	63.576
2500.	119.887	48.796	168.683	121989.3	63.717
2600.	121.812	49.375	171.187	128374.3	63.979
2700.	123.686	49.920	173.606	134784.2	64.216
2800.	125.511	50.435	175.946	141216.7	64.431
2900.	127.289	50.921	178.210	147669.7	64.626
3000.	129.024	51.380	180.404	154141.4	64.804
3100.	130.715	51.816	182.532	160630.0	64.967
3200.	132.367	52.229	184.597	167134.3	65.116
3300.	133.980	52.622	186.602	173652.8	65.253
3400.	135.557	52.995	188.552	180184.5	65.379
3500.	137.098	53.351	190.449	186728.3	65.495
3600.	138.606	53.690	192.296	193283.2	65.602
3700.	140.081	54.013	194.095	199848.5	65.702
3800.	141.526	54.322	195.848	206423.3	65.794
3900.	142.941	54.617	197.558	213007.1	65.879
4000.	144.327	54.900	199.227	219599.0	65.959
4100.	145.686	55.170	200.857	226198.7	66.033
4200.	147.019	55.430	202.449	232805.5	66.102
4300.	148.326	55.679	204.005	239419.0	66.167
4400.	149.609	55.918	205.527	246038.8	66.228
4500.	150.868	56.148	207.016	252664.4	66.284
4600.	152.105	56.369	208.473	259295.6	66.338
4700.	153.319	56.581	209.900	265931.9	66.388
4800.	154.513	56.786	211.299	272573.1	66.435
4900.	155.686	56.983	212.669	279218.8	66.479
5000.	156.839	57.174	214.012	285868.8	66.521
5100.	157.973	57.357	215.330	292522.9	66.561
5200.	159.088	57.535	216.623	299180.8	66.598
5300.	160.186	57.706	217.892	305842.4	66.633
5400.	161.266	57.872	219.138	312507.4	66.666
5500.	162.329	58.032	220.361	319175.6	66.698
5600.	163.376	58.187	221.563	325847.0	66.728
5700.	164.408	58.337	222.745	332521.2	66.757
5800.	165.423	58.482	223.906	339198.3	66.784
5900.	166.424	58.623	225.048	345877.9	66.810
6000.	167.411	58.760	226.171	352560.1	66.834
273.15	54.623	12.419	67.043	3392.3	21.245
298.15	55.746	13.241	68.987	3947.7	23.175
328.40	57.074	14.260	71.334	4683.1	25.432

Table 52. B_4C(crystal)

T	$-(F^\circ-H^\circ_0)/T$	$(H^\circ-H^\circ_0)/T$	S°	C°_p	$(H^\circ-H^\circ_0)$
°K	cal/°mole	cal/°mole	cal/°mole	cal/°mole	cal/mole
0.	0.0	0.0	0.0	0.0	0.0
50.	0.009	0.028	0.037	0.116	1.4
100.	0.090	0.300	0.390	1.214	30.0
150.	0.323	0.959	1.282	3.525	143.8
200.	0.731	1.976	2.707	6.594	395.2
250.	1.302	3.213	4.515	9.718	803.2
300.	2.006	4.554	6.560	12.728	1366.2
350.	2.81	5.95	8.76	15.77	2082.5
400.	3.70	7.33	11.03	18.09	2932.0
450.	4.64	8.63	13.27	19.82	3883.5
500.	5.61	9.82	15.43	21.20	4910.0
600.	7.60	11.90	19.50	23.37	7140.0
700.	9.57	13.66	23.23	25.02	9562.0
800.	11.49	15.17	26.66	26.33	12136.0
900.	13.35	16.47	29.82	27.28	14823.0
1000.	15.15	17.58	32.73	27.93	17580.0
1100.	16.86	18.55	35.41	28.39	20405.
1200.	18.52	19.38	37.90	28.72	23256.
1300.	20.10	20.11	40.21	28.97	26143.
1400.	21.61	20.75	42.36	29.17	29050.
1500.	23.06	21.32	44.38	29.32	31980.
1600.	24.46	21.82	46.28	29.5	34912.
1700.	25.80	22.27	48.07	29.6	37859.
1800.	27.08	22.68	49.76	29.7	40824.
1900.	28.32	23.05	51.37	29.8	43795.
2000.	29.51	23.39	52.90	29.8	46780.
273.15	1.614	3.826	5.440	11.184	1045.1
298.15	1.978	4.504	6.482	12.621	1342.9

PART II

SYSTEMS AND COMPOUNDS

CONTAINING TWO OR MORE LIGHT METALS

II. 1. ALLOYS AND INTERSTITIAL COMPOUNDS OF BERYLLIUM WITH ALUMINUM, MAGNESIUM, SILICON, TITANIUM, AND ZIRCONIUM

Thomas W. Mears

The alloy and intermetallic compounds of beryllium which may have some interest are discussed in this report. A literature search is underway for alloys and intermetallic compounds of aluminum, lithium, and magnesium with each other, and with silicon, titanium and zirconium. This work will be included in the next Technical Summary Report (July 1, 1961). In Appendix A of the present report phase diagrams of a number of binary metallic systems of interest have been reproduced from a well-known reference source [3].

When an intermetallic compound is formed between elements, a material more dense than that calculated on a partial atomic volume basis may be formed. Unfortunately, energy is lost as the heat of mixing (formation) of the alloy or interstitial compound. If this loss of energy is offset by the heat of mixing of the combustion products resulting from these alloys, then the volume efficiency of the alloy will be greater than either of the components. However, if these heats of mixing do not cancel out, then there is little advantage to using an alloy or intermetallic compound other than the possible improvement of combustion characteristics.

The data available on the intermetallic compounds of beryllium with aluminum, magnesium, silicon, titanium, and zirconium is rather sparse, being principally microscopic and x-ray data. No heat data are available for beryllium alloys. For some information on beryllium borides, see pp. 146 and 150.

Beryllium-Aluminum system

The complete liquid-solid equilibrium curve for the beryllium-aluminum system has been reported [1,2], and is shown in Fig. 2, Apprndix A. The eutectic temperature has been reported from 644° - 647°C [1,2,4,5] and the composition from 0.5 to 1.4 wt. percent (1.5 to 4.1 atom percent) [1,2,4,5,6,7]. The solid solubility of beryllium in aluminum has been determined by methods that give consistent results. These are hardness [4], lattice parameter [5], and microhardness [8,9]. These values range as follows:

Temp. (°C)	wt. % Be	at. % Be
645°C	0.05 - 0.06	0.15 - 0.17
600°C	0.02 - 0.03	0.06 - 0.09
500°C	0.005 - 0.01	0.014 - 0.03

The solubility is practically zero at lower temperatures. Thermal, microscopic, and hardness data indicate the formation of solid solutions on the beryllium side containing as high as 4-5 wt. % (1.4-1.7 at. %) aluminum [2]. However, paramagnetic and other microscopic studies show a solubility of definitely under 1 wt. % aluminum [10].

Lattice spacings have been determined for aluminum-rich solutions as follows [5,11]:

Wt % Be	Quenching Temp. (°C)	a(A)	D^{25}(g/ml)
0	630	4.0493	2.71
0.01	630	4.0488	2.78
0.02	630	4.0478	2.94
0.03	630	4.0473	3.13
0.04	630	4.0471	
0.05	600	4.0482	2-phase alloy (Al + Be)
0.06	r.t.	4.0493	

For the beryllium-rich side [12]:

Wt % Al	a(A)	c(A)	c/a at 25°C
0	2.2854	3.5829	1.5677
0.62	2.2853	3.5824	1.5677

Beryllium-Magnesium system

All attempts to dissolve beryllium in magnesium have been unsuccessful. These include heating the magnesium to its boiling point, the use of powder compacts, electrolytic deposition of beryllium on fused magnesium, and the reduction of beryllium fluoride with molten magnesium [13,14,15]. The rate of oxidation of high magnesium alloys is reduced by small additions of beryllium, but only traces are actually dissolved [16,17]. By heating magnesium and beryllium to the melting point of beryllium in 100 atmospheres of hydrogen, a microscopically homogeneous phase containing 0.5 wt. % beryllium was obtained. However, x-ray analysis did not indicate any true solubility of beryllium in magnesium [18].

A microscopic investigation indicates a solubility of magnesium in beryllium of up to 0.5 wt. % [12]. Another worker claims magnesium solubility of up to 1 wt. percent in beryllium [19].

An intermetallic compound $Be_{13}Mg$ has been prepared by powder metallurgy methods [20]. This compound has a face-centered cubic $NaZn_{13}(D2_3)$ structure with a = 10.166 ± 5A.

Beryllium-Silicon system

The liquid-solid phase diagram for the beryllium-silicon system has been determined [21], and is plotted in Fig. 10, Appendix A. This shows a eutectic composition of approximately 33 at. % (61 wt. %) silicon and a eutectic temperature of 1090°C. The eutectic data has also been determined [22] as 38.5 at. % (66.1 wt. %) silicon at 1090°C. From microscopic and x-ray work, the solubility of silicon in solid beryllium is negligible [12,23]. From the solid-liquid curve, the existence of a silicide claimed earlier is doubtful.

Beryllium-Titanium system

The existence of two beryllium-titanium compounds was noted earlier in addition to rather restricted terminal solid solutions. More recently, two additional intermetal compounds have been observed [24].

The lattice spacing for an alloy containing 0.73 percent titanium (quenched at 1000°C) is the same as pure beryllium [12]. The solubility of beryllium in β-titanium at 950°C is between 1 and 2 percent, while its solubility in α-titanium is less than 1 percent [25].

$Be_{12}Ti$ has a disordered hexagonal structure with 48 molecules to the unit cell, a= 29.44 A, c = 7.33 A, D = 2.30 g/cm^3 (macroscopic) [26]. However, this material was not observed in the powder patterns on samples prepared at UCRL [24].

Be_2Ti is a face-centered cube of the C15 ($Mg Cu_2$) type, where a = 6.448 A at 66.6 at. % beryllium. The composition is somewhat variable. A molal volume of 20.1 cm^3 has been reported for Be_2Ti [27].

$Be_{17}Ti_2$ exists in two modifications. α-$Be_{17}Ti_2$ has a rhombohedral lattice of the Nb_2Be_{17} type: a = 7.392 A and c = 10.79A. β-$Be_{17}Ti_2$ also has a rhombohedral lattice but is of the Th_2Ni_{17} type: a = 7.36A, and c = 7.30A [24].

Be_3Ti has a rhombohedral lattice and is of the $NbBe_3$ type: a = 4.49A, and c = 21.32A [24].

Compounds of the structure BeTi, Be_4Ti, and $Be_{10}Ti$ have been indicated by x-ray diffraction studies of sintered samples showing the appropriate analysis [28].

The data may be summarized as follows:

Compound	Type	Lattice Type	a(A)	c(A)	D(g/cm^3)
BeTi		(indicated)			
Be_2Ti	$MgCu_2$	Face-Centered Cube	6.448		3.3
Be_3Ti	$NbBe_3$	Rhombohedral	4.49	21.32	
Be_4Ti		(indicated)			
$Be_{10}Ti$		(indicated)			
$Be_{12}Ti$	$ThMn_{12}$	disordered hexagonal	29.44	7.33	2.30
α-$Be_{17}Ti_2$	Nb_2Be_{17}	Rhombohedral	7.392	10.79	
β-$Be_{17}Ti_2$	Th_2Ni_{17}	Rhombohedral	7.36	7.30	

Beryllium-Zirconium system

The liquid-solid phase diagram for the beryllium-zirconium system has been studied by means of microscopic and x-ray techniques [29]. A tentative diagram based on this data is shown in Fig. 11, Appendix A. From this diagram there appear to be four intermediate phases, $Be_{13}Zr$, Be_2Zr, Be_7Zr, and Be_4Zr. More recently other intermetallic compounds have been observed, such as Be_5Zr [24,30], $Be_{13}Zr$ [31], and $Be_{17}Zr_2$ [30].

Be_2Zr was shown by x-ray powder patterns to be of the hexagonal (AlB_2) structure, where a = 3.82A, c = 3.24A, U = 41.9A^3, and $D_{x\text{-}ray}$ = 4.32 g/cm^3. [32].

Be_5Zr has a hexagonal structure of the $CuZn_5$ type, where a = 4.564 ± 0.002A, c = 3.485 ± 0.002A, and Dx = 3.60 g/cm^3 [30].

$Be_{13}Zr$ has a face-centered cube with 8 entities per unit cell with a = 10.047A [31]. A density of 2.72 g/cm^3 has been calculated.

$Be_{17}Zr_2$ has a rhombohedral cell with a = 5.694 ± 0.005A, α = 83.02 ± 0.02° and Dx = 3.081 g/cm^3 [30]. It is isomorphous with Nb_2Be_{17}.

The solid solubility of zirconium in beryllium is slight, the lattice spacing for an alloy containing 0.65% zirconium being virtually the same as pure beryllium [12]. There is evidence to indicate some solid solubility of beryllium in zirconium [29]. There is an obvious eutectic at approximately 63 at. % (94 wt. %) zirconium at approximately 980°C [29,33]. This curve would also indicate a eutectic very close to 100% beryllium.

Contraction in Alloy Formation

The contractions of the metals upon the formation of alloys are shown in the following table. In general, this contraction runs about 2-2.5%. The notable exception is Be_2Zr, which shows an expansion on alloying of 5.42%. It should be pointed out that these values are small differences of relatively large numbers and are probably good to only ± 3%.

Since no heat-of-formation data is available for either the alloys or the rather complex mixtures of combustion products, it is difficult to assess the real worth of these contractions on mixing. If the heats of formation of the final mixtures of combustion products roughly offset the energy lost in the formation of the alloy, then the increase in density will result in an increase in heat of reaction per unit volume.

RELATIVE CONTRACTION ON FORMATION OF BERYLLIUM ALLOYS

Compound	Density	M.W.	Molecular Volume V_M	Sum of atomic volumes ΣV_A	Percent increase in volume $\frac{V_M - \Sigma V_A}{\Sigma V_A} \times 100$
$Be_{13}Mg$	1.83	141.49	77.3	77.7	-0.51
Be_2Ti	3.3	65.92	20.0	20.4	-1.96
$Be_{12}Ti$	2.30	156.06	67.8	69.4	-2.31
Be_2Zr	4.32	109.25	25.3	23.9	+5.86
Be_5Zr	3.60	136.29	37.9	38.6	-1.81
$Be_{13}Zr$	2.72	208.39	76.6	77.8	-1.54
$Be_{17}Zr_2$	3.081	335.66	108.9	111.5	-2.33
Be	1.85	9.013	4.9		
Mg	1.74	24.32	14.0		
Ti	4.507	47.90	10.6		
Zr	6.49	91.22	14.1		

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II. 2. THERMODYNAMIC PROPERTIES OF SOME BORIDES

George T. Armstrong and L. A. Krieger

The borides of the metals are a group of compounds to which little research activity was devoted for many years, although the existence of several of them has been known for 60 to 100 years. The lack of activity can probably be attributed to the difficulty of preparing and characterizing pure phases or even phases of completely known composition in the boron alloy system. There has been a striking increase in activity in the study of these compounds in recent years, and the growth of the literature has been so rapid as to make reviews both valuable and necessary. A list of ten papers of essentially a review nature, and sources of compiled data on the chemistry and physical properties of borides is given at the beginning of the references for this chapter. An indication of the rapid growth of activity in recent years is given by an examination of the references given in Aronsson [1], whose review is the most recent. Of 192 references only 40 were published prior to 1950. His review is a comprehensive and critical examination of the available information on the preparation, characterization and physical properties of the known borides. A second review by Aronsson [2] contains much of the same, and small amounts of different information. Another comprehensive review of the borides has been provided by Samsonov and Markovskii [3], which is very complete up to 1956. The authors have contributed to much of the recent Russian work in this field. From the relative numbers of references to Russian and American work in these reviews, it appears that the activity in the two countries is comparable in magnitude. Kieffer and Schwarzkopf [5] gave an earlier review (1953). Gmelin [6] provides uncritcal summaries of work on various borides in the appropriate volumes.

In a more specialized paper Brewer and Haraldsen [4] contributed a study of the thermodynamic properties of refractory borides, which has provided most of the thermodynamic data cited in the reviews previously mentioned. The estimates contained in it still remain the largest body of thermodynamic data available for the borides. Other compilations of data provide summaries of special properties of the borides. Hansen and Anderko [7] give phase diagrams and discuss the phase relationships; and Pearson [8] gives the lattice constants and structures of many borides. Reviews of more restricted fields have been given by Markovskii and Kondrashev [9] and by Kohn, Katz and Giardini [10].

No attempt has been made here to evaluate completely the thermodynamic properties of the borides, with the exception of the heats of formation. A selection of best values for the heats of formation is shown in Table 1. Some other thermodynamic data, however, are briefly mentioned in appropriate places in the discussion. In addition densities given by previous reviews are listed in Table 1. The borides will be briefly discussed by element, for Li, Na, Be, Mg, Al, Zr, Ti, C, N. In general heats of formation and other thermodynamic data are very incomplete. This state of affairs reflects the general lack of study of the borides as a group until recent years, and also the difficulty of obtaining samples adequately well characterized for thermodynamic studies to be meaningful.

Lithium

There is no real evidence for the formation of a lithium boride.

Sodium

While there is evidence that a hexaboride might possibly be formed under some conditions [3], no borides of sodium have been prepared.

Beryllium

The compound Be_2B has been prepared, its structure has been determined [1,3], but no thermodynamic information has been recorded.

Two compounds BeB_2 and BeB_6 are reported [1,3] but little information about them has been presented.

Magnesium

An early formula Mg_3B_2 still cited in some reference works is now thought not to occur [2,3].

MgB_2 has been prepared and its crystal structure determined [1,3]. The low temperature heat capacity was determined by Swift and White [11].

MgB_4 has been reported by Russel, Hirst, Kanda, and King [12]. The low temperature heat capacity was determined by Swift and White [11].

Two higher borides are reported [12] for which the formulas MgB_6 and MgB_{12} are proposed.

Aside from the specific heat data of Swift and White, no other thermodynamic data were found for the magnesium borides, although perhaps some estimates could be made of their relative stabilities on the basis of formation and decomposition temperatures.

Aluminum

The synthesis and structure of AlB_2 are well known. The phase diagram of the low boron range of the Al-B system has been given [7] though there is some inconsistency in reported data [3]. Likl and Jenitschek [13] (cited by [3]) claim AlB_2 is unstable at room temperature with respect to AlB_4 and the metal. The relationship of the latter phase to AlB_{10} reported by Kohn, et al [10] is not clear, as the compound AlB_4 is not mentioned by them.

No other information has been presented about AlB_4.

Kohn, et al [10] demonstrate the existence of AlB_{10} and have determined its structure.

Some confusion has existed about the compound AlB_{12} for which several structures have been reported. The structures were reviewed by Kohn, et al [10] who designated as α-AlB_{12} the red-transmitting, tetragonal, pseudo-cubic form which has been called a graphite-like form. They designated as β-AlB_{12} the amber colored, orthorhombic, pseudo-tetragonal form which has been called diamond-like. A third form, monoclinic AlB_{12} is stated by Kohn, et al [10] and by Parthé and Norton [14] to be in reality a crystalline form of boron.

The compound AlB_{12} was for a long time known as "crystallized boron". The specific heat of "diamond-like boron" was determined by Weber [15] over the range -40 to +260°C. This data can presumably be attributed to β-AlB_{12}. However, because at the time the work was done, the phases were not well understood, the validity of this assignment must be an open question.

No other measurements of thermodynamic properties have been found for the aluminum borides.

Titanium

Phases as follows have been reported for titanium borides Ti_2B (tetragonal or hexagonal), TiB (orthorhombic), TiB (cubic), TiB_2 (hexagonal), Ti_2B_5 (hexagonal) and TiBx (x ~ 10) [1,3,16]. Of these Aronsson [1] is of the opinion that the phase identified as "Ti_2B" is in reality TiB (orthorhombic) and that the phase identified as TiB (cubic) is in reality a Ti(O,B) phase.

Brewer and Haraldsen [4] have estimated heats of formation, ΔHf°_{298}, of the borides of titanium as follows: $\frac{1}{x}TiB_x$ (x < 2), ~ -36; $\frac{1}{2}TiB_2$, ~ -36; $\frac{1}{5}TiB_5$, < -21 kcal/mole B. These values are based on the relative stabilities of the borides in the presence of graphite and the fact that Ti will reduce Mo and W borides. No other data is known which is applicable to the titanium borides other than TiB_2. For TiB_2 several experimental measurements have been made of the heat of formation. Samsonov and Markovskii [3] cite the value -70.04 kcal/mole TiB_2, without prior reference. This value is also given by Samsonov [17] in an experimental report on the thermodynamic relations between TiO_2, TiO, Ti_2O_3, B_4C, TiB_2, C and CO. Without translation we have been unable to determine whether or not this quantity was derived from the equilibria studied. Essentially the same value is given by Krestovnikov and Vendrikh [18]. The abstract is obscure, and does not clearly indicate the mode of obtaining the heat of formation.

The heats of combustion of boron and of TiB_2 were determined by Epel'baum and Starostina [19] by oxygen-bomb calorimetry. They report ΔHf°_{298} = -66.85 ±2.68 kcal/mole for TiB_2 and 287.8 ±2.17 or 289.47 ±3.1 for B_2O_3. Because the heat measurement itself is not given in the abstract, it is not possible to know whether the value reported for the heat of formation of TiB_2 is consistent with the value for the heat of formation of TiO_2 used in these reports (See NBS Report 6645 for example). The heat of combustion of B found by Epel'baum and Starostina is appreciably lower than the accepted heat of formation of B_2O_3 (-305.34 ±0.30 kcal/mole [20]). This fact suggests that the heat measurement may have had an error of method.

Considering the various estimates and measurements, we select -70.0 ±4.0 kcal/mole as the best value for the heat of formation of TiB_2.

Preliminary vaporization studies on TiB_2 have been made by Schissel and Williams [21]. Margrave and co-workers [22] report that they are measuring the heat content of TiB_2 at high temperatures. Krestovnikov and Vendrikh [18] tabulate the heat, entropy and free energy of formation of TiB_2 between 298° and 3253°K.

Zirconium

Three zirconium borides are currently considered to exist, ZrB, ZrB_2 and ZrB_{12}. Of these Aronsson [1] casts doubt on the reality of ZrB. Of the three ZrB_2 is the most stable.

Brewer and Haraldsen [4] estimated the heats of formation of the zirconium borides on the basis of their stabilities in the presence of graphite and the fact that Zr will reduce Mo and W borides. They estimate ΔHf per gram atom of boron to be < -39 kcal/mole for ZrB and ZrB_2, and < -10 kcal/mole for ZrB_{12}. Krikorian [26] estimated the heat of formation of ZrB as -47 kcal/mole.

Epel'baum and Starostina [19] found ΔHf° = -75.02 ±3.35 kcal/mole $ZrB_{2.05}$ after determining the heat of combustion of B to be -287.8 ±2.17 or -289.47 ±3.1 kcal/mole. Because the value for the heat of combustion for boron appears to be low, the heat of formation of $ZrB_{2.05}$ may be in error, either because of incomplete combustion or the use of a low value for the heat of formation of B_2O_3.

Holley, Huber, Head, and Fitzgerald [23] have determined the heat of combustion of relatively impure samples of ZrB_2. Because of the relatively large impurities in the samples, the results are not considered to be complete. Values found on two samples were -76.4 ±1.45 kcal/mole and -73.1 ±3.1 kcal/mole.

Leitneker [24] studied the evaporation behavior and vapor pressure of a sample ($ZrB_{1.906}$) approximating to the composition of ZrB_2. They found ΔH_0° = 458.3 ±6.5 kcal/mole for the heat of vaporization to the atoms.

$$ZrB_{1.906} = Zr(g) + 1.906\ B(g)$$

Using ΔH_0° [Zr(g)] = 145.5 kcal/mole [25] and ΔHf_0° B(g) = 133.0 kcal/mole (See Part I.) we calculate $\Delta Hf_0^\circ[ZrB_{1.906}]$ = -59.3 kcal/mole from Leitneker's data. This deviates significantly from the values cited above, assuming the heat of formation at 298°K is essentially equal to that at 0°K.

Of these measurements, that by Holley, et al [23] on their most nearly pure sample is taken as the best value, -76.4 kcal/mole. Because of the uncertainty in their own work, the value by Epel'baum and Starostina, and the estimate by Brewer and Haraldsen the uncertainty is taken as ±5 kcal/mole.

Walker, Ewing and Miller [27] determined the heat capacity of titanium diboride from 30° to 700°C.

Carbon

There are two boron carbides B_4C and $B_{13}C_2$. The heat of combustion of B_4C was determined by Smith, Dworkin and Van Artsdalen [28] to be $\Delta H^\circ_{c\,298} = -683.8$ kcal/mole. Combined with the heat of formation of B_2O_3, amorphous, this leads to -12.2 kcal/mole for the heat of formation. The data of Robson and Gilles [29] on the decomposition pressures of B_4C are consistent with this value. Samsonov [3] in his review lists -66.0 kcal/mole for the heat of formation of B_4C. He gives no source, and the source of the number is difficult to find. Samsonov [30] in another article, refers for this value to Markovskii, Orshanskii and Prinishnikov [31]. In the absence of further information indicating its derivation, this heat of formation must be disregarded for the time being.

There are no thermochemical data for $B_{13}C_2$.

Nitrogen

Two forms of boron nitride, BN, are known, the graphite-like form and a diamond-like form. The heat of combustion, -90.2 kcal/mole of the graphite-like form, was determined by Dworkin, Sasmor, and Van Artsdalen [32], leading to a heat of formation of -60.3 kcal/mole. Samsonov [3], without reference to other data gives -33.5 kcal/mole for the heat of formation.
This appears to be based upon early work such as was summarized by Kelley [33]. However, in a more recent paper Galchenko, Kornilov and Skuratov [34] directly determined the heat of reaction of boron and nitrogen and find -60.7 ±0.34 kcal/mole for the heat of formation of BN from crystalline boron and nitrogen. This is slightly lower than the value found by Dworkin, Sasmor and Van Artsdalen. The general agreement of these values, together with others discussed in Part I, indicates that the heat of formation of BN is not uncertain by more than 1 kcal/mole.

Table 1

Heats of Formation of Light Metal Borides

Formula	ΔHf^{o}_{298} kcal/mole	Density g/cm^3
Lithium Boride	No compounds known	
Sodium Boride	No compounds known	
Be_2B (cubic)	-	2.15 [3] 1.9 x [3]
BeB_2 (?)	-	-
BeB_6 (?)	-	-
MgB_2 (hexagonal)	-	2.667 [1] 2.48 - 2.67 [3]
MgB_4	-	-
MgB_6 (?)	-	-
MgB_{12} (?)	-	-
AlB_2 (hexagonal)	-	-
AlB_4 (orthorhombic)	-	-
AlB_{10}	-	2.537 ±0.003 [10]
$AlB_{12}(\alpha)$ (tetragonal)	-	2.547 - 2.660 [3]
$AlB_{12}(\beta)$ (orthorhombic)	-	2.49 - 2.59 [3]
Ti_2B (?)	~ -36	-
TiB (orthorhombic)	~ -36	4.56 x [1]
TiB (?) (cubic)	~ -36	5.26 x [3] 5.09 [3]
TiB_2 (hexagonal)	-70 ±4	4.478 x [1] 4.52 x [3] 4.45 [3]
Ti_2B_5 (hexagonal)	< -105	4.63 x [1]
TiB_x (x ~ 10)	-	-
ZrB (cubic)	< -39 [4]	7.03 x [3] 5.7 [3]
ZrB_2 (hexagonal)	< -76.4 ±5	6.082 x [1] 5.82 [3]
ZrB_{12} (cubic)	< -120 [4]	3.63 x [3] 3.70 [3]
B_4C rhombohedral	-12.2	2.51 [1] 2.52 ±0.01 [3]
$B_{13}C_2$ rhombohedral	-	2.44 [3]
BN (hexagonal)	-60.3	2.27 x [1] 2.29 ±.03 x [3]
BN (cubic)	-	-

x denotes X-ray determination.

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II. 3. PHASE RELATIONS AND PROPERTIES OF SOME MIXED OXIDE AND OXIDE-FLUORIDE SYSTEMS

R. F. Walker

This chapter summarizes a survey of the published data on the phase relations which exist among the mixed oxides and oxide-fluoride mixtures of Al, B, Be, Li, Mg, Ti, and Zr. Of the large number of binary and multi-phase systems which may be obtained by combining the various oxide and fluoride phases, relatively few have been studied at all, and even then available information is confined to condensed phases under 1 atmosphere pressure of air.[1] A summary of the following pertinent physical properties has also been compiled: density, crystal structure, lattice parameters and heats of formation.

While the survey is not yet exhaustive, it is believed to cover most of the more reliable information.

A. Phase Diagrams

A compilation of selected phase diagrams is given in Appendix A (Figs. 20-45). In general, these diagrams effectively summarize the most reliable information on the behavior of the mixed systems. The abscissae of the diagrams represent weight % of constituents, unless otherwise stated. Some further details on these and other systems are included in the following discussion.

Al_2O_3-BeO

The liquidus curve for this system was given by von Wartenberg et al [1], but was probably correct only in terms of its very general shape. The alumina-rich end of the diagram was investigated in some detail by Foster and Royal [2], and again by Lang et al [3]. The diagram of the latter authors (Fig. 20) gives the most complete detail, showing two phases, $BeO \cdot Al_2O_3$ and $BeO \cdot 3Al_2O_3$, melting congruently at 1870° and 1910°C respectively. The partial diagram of Foster and Royal is in general agreement with that of Lang et al, except the temperatures are 10-30°C higher. It should be noted that both take the Al_2O_3 melting point as 2015°C, which is close to the lower limit of the value recommended in NBS Report No. 6484, viz., 2030 ±20°C.

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[1] In the interpretation of the condensed systems, the pressure variable is eliminated and the variance (F) of the systems is given by

$$F = C-P+1,$$

where C is the number of components and P is the number of phases.

AlF_3-LiF-Al_2O_3

Drossbach [4] published a very small portion diagram (Fig. 21), showing a compound $3LiF \cdot AlF_3$.

Al_2O_3-BeO-MgO

This system was investigated by Geller, et al [5], who broadly mapped out the single- and multi-phase regions (Fig. 22).

Al_2O_3-BeO-TiO_2

Figure 23 shows the diagram for this system as determined by Lang, et al. [3].

Al_2O_3-BeO-ZrO_2

Part of this system was investigated by Geller, et al [5], and is shown in Fig. 24.

Al_2O_3-MgO

The liquidus curve of this system was given by von Wartenberg and Reusch [6] and by von Wartenberg and Prophet [7]. The general form of the curves is in agreement with an earlier diagram given by Rankin and Merwin [8] and shown in Fig. 25. A recent modification to the Al_2O_3-rich end of this diagram has been proposed by Osborn [9], and is shown in Fig. 26. Spinel, $Al_2O_3 \cdot MgO$, which melts congruently at 2135°C, is the only known phase in the system apart from the parent phases.

Al_2O_3-MgO-TiO_2

This system was investigated by Berezhnoi and Gulko [10]. The liquidus surface for the system is shown in Fig. 27, and the composition diagram for primary phases is given in Fig. 28. The cross-hatched lines in the latter figure indicate solid solutions.

Al_2O_3-TiO_2

An approximate liquidus curve for this system was given by von Wartenberg and Reusch [6]. The data was in fair agreement with that of Bunting [11], whose diagram shows the compound $Al_2O_3 \cdot TiO_2$ melting congruently at 1860°C. The latest diagram, given by Lang et al [3], is shown in Fig. 29. The liquidus curve for this system is probably somewhat uncertain, particularly at the Al_2O_3-rich end of the composition range.

Al_2O_3-TiO_2-ZrO_2

The melting isotherms and primary phases for this system, as obtained by Berezhnoi and Gulko [12], are shown in Figs. 30 and 31 respectively.

BeO-MgO-ZrO_2

Part of this system was studied by Lang, Maxwell and Geller [13]. No compound formation was reported. Their diagram is shown in Fig. 32.

BeO-TiO_2

The liquidus curve for compositions containing up to 85% BeO was given by von Wartenberg, et al [1]. Limited data or proposals on the TiO_2-rich end of the diagram were as published by Lang et al [3], and are shown in Fig. 33. No compound formation has been reported in this system.

BeO-TiO_2-ZrO_2

Lang, Roth and Fillmore [14] presented data on the liquidus surface and the composition diagram of the system at 1550°C. The data are shown in Figs. 34 and 35 respectively.

Li_2O-B_2O_3

An investigation of this system by Mazzetti and de Carli [15] suggested that five phases exist in the compositional range 50-85% B_2O_3, all phases melting congruently. The phases were: $Li_2O \cdot B_2O_3$; $Li_2O \cdot 2B_2O_3$; $Li_2O \cdot 3B_2O_3$; $Li_2O \cdot 4B_2O_3$; $Li_2O \cdot 5B_2O_3$. Subsequent investigations by Rollet and Bonazig [16] and by Sastry and Hummel [17] only partially confirmed this picture. The diagrams of the two latter groups of authors are shown in Figs. 36 and 37 respectively. They found two phases only which melted congruently (namely $Li_2O \cdot B_2O_3$ and $Li_2O \cdot 2B_2O_3$ at 840-849°C and 915-917°C respectively), and did not confirm the existence of an $Li_2O \cdot 5B_2O_3$ phase. However, several other phases were proposed, as shown in the figures.

MgO-B_2O_3

Davis and Knight [18] identified two phases in this system, $2MgO \cdot B_2O_3$ and $3MgO \cdot B_2O_3$, which melt congruently at 1340 and 1356°C respectively. Their diagram is shown in Fig. 38.

$MgO-TiO_2$

Von Wartenberg and Prophet [7] studied the system and found two phases having compositions corresponding to $2MgO \cdot TiO_2$ and $MgO \cdot 2TiO_2$, both melting congruently. Royster [19] identified a congruent melting phase $MgO \cdot TiO_2$, but did not report finding the two congruent-melting phases of von Wartenberg and Prophet. Royster's diagram is shown in Fig. 40. The most recent and complete investigation of the system was made by Coughanour and DeProsse [20]. They found the three phases, $2MgO \cdot TiO_2$, $MgO \cdot TiO_2$, and $MgO \cdot 2TiO_2$, which melt congruently at 1732, 1630 and 1652°C respectively, as shown in Fig. 39.

$MgO-ZrO_2$

Zhirnova [21] sketched out the phase relations believed to occur in this system, as shown in Fig. 41. MgO "stabilizes" the cubic form of ZrO_2 over a fairly wide composition range, and over an ill-defined temperature range. No other new phases have been reported to form in this system. An alternative diagram at the ZrO_2-rich end of the system has been given by Duwez, et al [22], and is shown in Fig. 42.

$MgO-TiO_2-ZrO_2$

Coughanour et al [23] estimated the extent of solid solution in this system over the temperature range 1400-1750°C. Their diagram is shown in Fig. 43.

TiO_2-ZrO_2

A liquidus curve for this system was published by von Wartenberg and Gurr [24]. Sowman and Andrews [25] investigated the system by quenching and x-ray diffraction techniques, but did not find any new phases beyond the "stabilized", cubic form of ZrO_2. Their data is otherwise not grossly different from that of Brown and Duwez [26], and Coughanour et al [27], who show an incongruently melting compound, $ZrO_2 \cdot TiO_2$. Their suggested diagrams are shown in Figs. 44 and 45, respectively.

$MgO-MgF_2$

This system has recently been investigated by Hing and Kunth [28] and found to be simply eutectic. The eutectic temperature was 1214°C. No solid solution was detected by refractive index or x-ray analysis.

In addition to the publications mentioned above, the following references have been noted, but were seen either in abstract only or too late for inclusion in the foregoing discussion.

System	Reference
$BeO-TiO_2$	[29]
$BeO-ZrO_2$	[29]
$BeO-TiO_2-ZrO_2$	[30]
ZrO_2-TiO_2	[29]
$Li_2O-Al_2O_3-TiO_2$	[31]
$B_2O_3-Al_2O_3$	[32]
$Al_2O_3-TiO_2$	[31]
$Li_2O-Al_2O_3$	[31]
Li_2O-TiO_2	[31]

B. Some Physical Properties

Thermodynamic data on the mixed oxide and oxide-fluoride systems is scarce. However, the very limited existing data on the heats of formation of the compounds or the heats of mixing of the components has not been completely reviewed yet. The use of phase diagrams to determine the heats of mixing is usually not reliable, owing to the uncertainties in the temperatures of the liquidus curves or of the ideality of the solutions.

A limited amount of data on the crystal structure and densities of some of the mixed oxide systems has been located. These are compared with data for the single-component systems in the following table. The data have not been critically evaluated, but have been selected to be fairly representative of literature values. They are in no sense "best" values. Further data and references on these properties will be given in subsequent reports.

Crystal Structures and Densities of Some Oxide Systems

System	Crystal Structure	Lattice Constants. Å.	Theoretical or Maximum Density[1]
Al_2O_3	Hex.	a = 4.75 c = 12.97	3.96
BeO	Hex.	a = 2.963 c = 4.370	3.03
Li_2O	Cub.	a = 4.628	2.01
MgO	Cub.	a = 4.213	3.58
TiO_2	Rhomb.	a = 4.492 c = 4.893	4.17
	Tetrag.	a = 3.73 c = 9.37	4.24
ZrO_2	Monoclinic	99° 28' a = 5.375 b = 5.26 c = 5.21	5.56
	Tetrag.	-	6.10
Al_2O-TiO_2	-	-	3.68
BeO·Al_2O_3	Ortho.	a = 5.47 b = 9.39 c = 4.42	3.76
MgO·Al_2O_3	Cub.	a = 8.08	3.58
2MgO·TiO_2	Cub.	a = 8.44	-
MgO·TiO_2	Hex.	a = 4.99; 5.09 c = 13.70; 14.09	- 3.66
MgO·2TiO_2	Cub.	-	
ZrO·Al_2O_3	Cub.	-	4.58

[1] In most cases the densities are approximate theoretical densities calculated from the lattice constants. Some densities are the maxima that have been obtained using ceramic fabrication processes.

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II. 4. PHASE BEHAVIOR OF BINARY SYSTEMS OF Li, Al, Be, Mg, and Zr FLUORIDES AND CHLORIDES

George T. Furukawa

Recently interest has become directed toward mixed inter-metal halides. As a part of the program to determine thermodynamic properties, a survey was made of the phase behavior of inter-metal halide systems in order to obtain information on the existence of inter-metal halide compounds and how they could be prepared. For the present survey only the binary systems of the inter-metal fluorides and chlorides were considered. The compilation entitled Phase Diagrams for Ceramists, Parts I and II [10,9], was consulted to locate references to the original literature and from these to other references. Another compilation entitled Phase Diagrams of Nuclear Reactor Materials [18] was also consulted. No effort was made to review the literature since the above compilations. Phase information has been found on the systems LiF-LiCl, LiF-BeF_2, LiF-MgF_2, LiF-AlF_3, LiF-ZrF_4, and BeF_2-MgF_2. For purposes of illustration and discussion, phase diagrams given in the former compilation were reproduced and new figure numbers assigned. Diagram references to other related systems have also been reproduced from the former compilation. The phase systems are discussed in the order listed above.

LiF-LiCl System

Botschwar [2] investigated phase relationships of several binary lithium halide systems. The LiF-LiCl system, shown in Fig. 46, was found to be completely miscible in the liquid phase and immiscible in the solid phase. The eutectic occurs at about 80 mole percent LiCl and 485°C. The LiCl-LiBr system was found to show continuous solid-solution formation with a minimum at about 75 mole percent LiBr and 520°C. The LiF-LiBr system shows a eutectic at about 90 mole percent LiBr and 453°C. There is shown a slight solid phase solution of LiBr in LiF.

LiF-BeF_2 System

Phase studies of the LiF-BeF_2 system have been published by Thilo and Lehmann [17]; Roy, Roy, and Osborn [13]; Novoselova, Simanov, and Jarembash [11]; and Roy, Roy, and Osborn [15]. The comparable ionic radii associated with fluoroberyllate and silicate tetrahedra have drawn considerable interest and the phase behavior of the two systems has been compared in a number of papers. For example, Thilo and Lehmann [17] have reported a similarity between LiF-BeF_2 and MgO-SiO_2 systems; Roy, Roy, and Osborn [13,15] have indicated that the compound Li_2BeF_4 formed more closely resembles Zn_2SiO_4 than Mg_2SiO_4. A number of fluoroberyllate glasses is also known [8], in particular involving three or more fluorides. Many of the fluoroberyllate glasses as compared to the silicate glasses are not as

water resistant, have lower refractive indices, have higher transmission coefficient for ultraviolet and infrared radiations, and have relatively lower melting temperatures. The phase investigations of Thilo and Lehmann [17] on the LiF-BeF_2 system by thermal analysis reveal the formation of the compound Li_2BeF_4 and indicate the existence of the incongruently melting compound $LiBeF_3$. The possible existence of the compounds $Li_3Be_2F_7$ and $LiBe_2F_5$ is indicated. The work by Roy, Roy, and Osborn [13] done about the same time using the quenching technique was primarily in the region of the liquidus and solidus curves. Any subsolidus phase transformations that occurred were not investigated. In a subsequent investigation, Roy, Roy, and Osborn [15] investigated the LiF-BeF_2 system more thoroughly using a bombination of quenching, thermal analysis, x-ray, and petrographic methods. The compound Li_2BeF_4 (melting point: 458°C) was observed, but the observed compound $LiBeF_3$ was not found to be of the incongruently melting type. It is shown to be formed in a subsolidus transformation. The BeF_2-Li_2BeF_4 eutectic was found to occur at about 48 mole percent LiF and 350°C and the LiF-Li_2BeF_4 eutectic at about 75 mole percent LiF and 455°C. As shown in Fig. 47, several subsolidus transformations have been observed and the compounds $LiBeF_3$ and $LiBe_2F_5$ have been obtained. BeF_2 is shown to exist in two crystalline forms of the α and β quartz structures, depending upon the temperature. Roy, Roy, and Osborn [13,15] observed only one crystalline form of Li_2BeF_4; Novoselova, Simanov, and Jarembash [11], however, observed three polymorphic forms:

$$\alpha - Li_2BeF_4 \overset{178°C}{\rightleftharpoons} \beta - Li_2BeF_4 \overset{328°C}{\rightleftharpoons} \gamma - Li_2BeF_4 .$$

The latter investigators observed also three forms of BeF_2:

$$\alpha - BeF_2 \overset{217°C}{\longleftrightarrow} \beta - BeF_2 \overset{337°C}{\longleftrightarrow} \gamma - BeF_2 .$$

In a recent compilation [18] which included some unpublished data, shown in Fig. 48, a peritectic point involving liquid-LiF-Li_2BeF_4 is given. It seems that additional careful work is needed to establish whether Li_2BeF_4 is a congruently melting compound.

LiF-MgF_2 System

The earlier phase studies of Bergman and Dergunov [1], using the thermal analysis method, show formation of a continuous series of solid solutions between LiF and MgF_2 with a minimum at 742°C and 33 mole percent MgF_2 (Fig. 49). Thermal analysis work reported even earlier by Tacchini [16] shows an unbroken series of solid solutions in the region of 0 to 60 mole percent MgF_2. Above 60 mole percent MgF_2, the liquidus curve data only have been reported. A minimum is shown at about 60 mole percent MgF_2 and 670°C.

X-ray investigations, however, by Bruni and Levi [3] and by Zintl and Udgård [20] show no change in the crystal constants of LiF and MgF_2 on examination of their cooled mixed melts. A more recent phase study by Counts, Roy, and Osborn [4], shown in Fig. 50, indicates that the LiF-MgF_2 system forms discontinuous solid-solutions with a eutectic at 735°C and 36 mole percent MgF_2. Exsolution takes place at lower temperatures and at room temperature no appreciable solution exists between LiF and MgF_2. Counts, Roy, and Osborn [4] used a combination of quenching, thermal analysis, x-ray, and petrographic techniques. No compounds of LiF and MgF_2 have been reported.

LiF-AlF_3 System

Phase investigations of the LiF-AlF_3 system have been published for the range 0 to 37 mole percent AlF_3 by Puschin and Baskow [12] and for the range 0 to 45 mole percent AlF_3 by Fedotieff and Timofeeff [6] in connection with their interest in the formation of other cryolite-type compounds by other alkali fluorides. In Fig. 51 is shown the results obtained by Fedotieff and Timofeeff [6]. The melting point of Li_3AlF_6 was found to be about 790°C. The LiF-Li_3AlF_6 eutectic occurs around 15 mole percent AlF_3 and 715°C. A compound comparable to the incongruently melting compound $5NaF \cdot 3AlF_3$ found by Fedotieff and Iljinsky [5] in the NaF-AlF_3 system (Fig. 52) was not observed by Fedotieff and Timofeeff [6], with the LiF-AlF_3 system or with the KF-AlF_3 system (Fig. 53). Puschin and Baskow [12] have investigated also the systems NaF-AlF_3, KF-AlF_3, RbF-AlF_3 and have stated the possible existence of the compounds $2AlF_3 \cdot 3NaF$, $2AlF_3 \cdot 3KF$ and $2AlF_3 \cdot 3RbF$. The upper concentration limit of their investigations was 40 mole percent AlF_3. A better interpretation of the results shown would seem to be a possible eutectic rather than a compound formation at about 40 mole percent AlF_3. Fedotieff and Timofeeff [6] indicate a eutectic between K_3AlF_6 and possibly AlF_3 at 45 mole percent AlF_3 and 565°C and a eutectic between Li_3AlF_6 and possibly AlF_3 at about 36 mole percent AlF_3 and 710°C. Because of the relatively high vapor pressure of AlF_3, no liquid-solid phase information is available at concentrations greater than 45 mole percent AlF_3. It is expected that the incongruently melting compound $5NaF \cdot 3AlF_3$ observed by Fedotieff and Iljinsky [5], the compounds $2AlF_3 \cdot 3NaF$, $2AlF_3 \cdot 3KF$, and $2AlF_3 \cdot 3RbF$ suggested by Puschin and Baskow [12], and the eutectics of K_3AlF_6 and Li_3AlF_6 with possibly AlF_3 observed by Fedotieff and Timofeeff [6] are very closely related. Careful and precise phase studies in the 40 mole percent AlF_3 region may reveal the actual phases present.

$LiF-ZrF_4$ System

Unpublished work on the $LiF-ZrF_4$ system from 0 to 100 mole percent ZrF_4 performed by R. E. Moore, F. F. Blankenship, W. R. Grimes, H. A. Friedman, C. J. Barton, R. E. Thoma, and H. Insley [18] at the Oak Ridge National Laboratory during the period 1951 to 1956 is shown in Fig. 54. The heptafluorozirconate Li_3ZrF_7 is shown to be formed, which through subsolidus transformation becomes LiF and Li_2ZrF_6 below about 470°C. The incongruently melting compound $3LiF \cdot 4ZrF_4$ is shown which is also unstable below about 466°C. The only stable compound at room temperature between LiF and ZrF_4 is shown to be Li_2ZrF_6 (melting point = 596°C). The $LiF-Li_3ZrF_7$ eutectic is located at 21 mole percent ZrF_4 and 598°C, the $Li_3ZrF_7-Li_2ZrF_6$ eutectic at 29.5 mole percent ZrF_4 and 570°C, and the $Li_2ZrF_6-3LiF \cdot 4ZrF_4$ eutectic at 49 mole percent ZrF_4 and 507°C. The liquid-$ZrF_4-3LiF \cdot 4ZrF_4$ peritectic is located at 51.5 mole percent ZrF_4 and 520°C. The melting point of Li_3ZrF_7 was found to be 662°C. The compound Li_4ZrF_8 to which reference is found (W. B. Blumenthal, The Chemical Behavior of Zirconium, D. van Nostrand Co., New York, 1958) is not shown.

BeF_2-MgF_2 System

The earlier phase investigations of Venturello [19] on BeF_2-MgF_2 by thermal analysis and x-ray methods show (Fig. 55) continuous solid-solution formation with a minimum at about 90 mole percent BeF_2. Between 80 and 100 mole percent BeF_2, data on only the liquidus curve have been reported. The work of Counts, Roy, and Osborn [4], shown in Figure 56, utilizing the quenching method in the range 50 to 100 mole percent BeF_2, does not show any evidence of solid-solution formation. A eutectic at 95 mole percent BeF_2 and 528°C has been found. The results do not show any compound formation.

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PART III

NEW AND REVISED

THERMODYNAMIC PROPERTIES

III. 1. REFERENCES TO RECENT VALUES FOR HEATS OF FORMATION

George T. Armstrong and Leslie A. Krieger

The following section is a compilation of references to papers containing material relevant to the evaluation of heats of formation of compounds listed in these reports, received since NBS Report 6928 was prepared.

A. Aluminum Compounds

1. Mass Spectra of Aluminum III Halides and the Heat of Dissociation of $Al_2F_6(g)$ and $LiF{\cdot}AlF_3(g)$, R. F. Porter and E. E. Zeller, J. Chem. Phys. 33, 858 (1960).

2. Dissociation Energies of the Gaseous Monohalides of Boron, Aluminum, Gallium, Indium and Thallium, R. F. Barrow, Trans. Faraday Soc. 56, 952-8 (1960).

3. Aluminum Monochloride, C.A. 54, 19252d (1960)
S. A. Semenkovich, Zhur. Priklad. Khim. 33, 1281-5 (1960)

   Equilibrium constants were determined for the reaction $2Al + AlCl_3 = 3AlCl$.

4. Chemical Reactions of Aluminum Monohalide Vapors, C.A. 54, 20735a (1960), S. A. Semenkovich, Zhur. Priklad. Khim. 33, 552-9 (1960).

   Aluminum monofluoride and monochloride reactions with O_2, H_2O, CO, N_2, BeO, MgO, CaO, B_2O_3, SiO_2, TiO_2, ZrO_2, Al_2O_3, W, Mo, Fe, Ni, Cr, Cu, C, SiC, TiC were studied. It is unclear from the abstract whether new reaction equilibria are presented.

5. Heating Curves of Aluminum Oxide Trihydrate and the Phase Changes Occurring During the Process of Registration, C.A. 54, 23680d (1960) A. I. Tsvetkov, E. P. Val'yashikhina and A. D. Las'kova, Trudy Inst. Geol. Rudnykh Mestorozhdenii, Petrog. Mineral. i Geokhim. 1960, No. 42, 21-40.

6. Mass Spectra of Vapors in the Al-AlF_3 and Al-LiF-AlF_3 Systems, R. F. Porter, J. Chem. Phys. 33, 951 (1960).

B. Beryllium Compounds

1. Composition of Vapors in Equilibrium with Salts at High Temperatures, J. Berkowitz and W. A. Chupka, Ann. N.Y. Acad. Sci. 79, Art 11, 1073-8 (1960).

   BeF_2, $FeCl_2$ and the systems BeF_2-LiF and $FeCl_2$-LiCl were studied.

2. Beryllium Fluoride. II. Formation of Beryllium Fluorides in Solution, Apurba Kumar Sengupta (Univ. Coll. Sci. Calcutta), J. Indian Chem. Soc. 37, 291-4 (1960).

   The existence of BeF^+, $BeF_2(ag)$, BeF_4^{-2} and H_2BeF_4 is confirmed. The existence of BeF_3^-, BeF_5^{-3}, BeF_6^{-4}, and $HBeF_3$ was not corroborated.

3. The Electromotive Force Method of Investigating the Thermodynamics of Certain Reactions at High Temperatures, C.A. 54, 19117a (1960, M. V. Smirnov, L. E. Ivanovskii, S. F. Pal'guev, Z. S. Volenkova and L. D. Yushina, Trudy Inst. Khim. Akad. Nauk SSSR, Ural Filial 1958, No. 2, 143-51.

   Some reactions studied involved Be, Ca, Th, chlorination of BeO, dilution of $BeCl_2$ with alkali metal chlorides, the formation of $BeCl_4^=$, and the reduction of oxides with carbon, forming carbides.

C. Magnesium Compounds

1. X-Ray Study of the Factors Causing Variation in the Heats of Solution of Magnesium Oxide, D. K. Thomas and T. W. Baker, Proc. Phys. Soc. (London) 74, Pt. 6, 673-9 (1959).

2. Thermodynamic Properties of Water in Aqueous Solutions, C.A. 54, 19102i (1960), K. P. Mishchenko, Termodynam. i Stroenie Rastvorov, Akad. Nauk SSSR Otdel. Khim. Nauk i Khim. Fak. Moskov. Gosudarst. Univ., Trudy Soveshchan., Moscow 1958, 97-105 Publ. 1959).

   The heat and entropy of solution of $MgCl_2$ are given.

3. Tensimetric and Thermochemical Study of Aqueous Solutions of the Electrolytes $CoCl_2$, NH_4Cl, $NaCl$, and $MgCl_2$, C.A. 54, 16119h (1960), N. A. Kupina, Trudy Leningrad. Tekhnol. Inst. im. Lensoveta 40, 92-111 (1957).

   Vapor pressures and heats of solution of each of the above salts are given.

D. Lithium Compounds

1. Mass Spectrometric Investigation of the Evaporation of Sodium Chloride and Lithium Fluoride with the Use of a Double Effusion Chamber, C.A. 54, 18007b (1960), P. A. Akishin, L. N. Gorokhov and L. N. Sidorov, Vestnik Moscov. Univ. Ser., Mat., Mekh., Astron., Fiz. i Khim. 1959, No. 6, 194-204.

   LiF, $(LiF)_2$, $(LiF)_3$, NaF, $(NaF)_2$, $(NaF)_3$ were observed and heats of sublimation and dissociation were measured.

2. Vapor Pressure Equations for Species Over Solid and Liquid LiF, R. S. Scheffee and J. L. Margrave (Atlantic Research Corp.), J. Chem. Phys. 31, 1682-3 (1959).

3. See Reference B. 1., Berkowitz and Chupka, LiF-BeF_2 and $LiCl$-$FeCl_2$ systems.

4. See Reference A.1., Porter and Zeller, LiF-AlF_3 gas.

5. See Reference E.2., Schoonmaker.

6. See Reference A.6., Porter.

7. See Reference E.3., Datz.

E. Sodium Compounds

1. See Reference D.1., Akishin, Gorokhov and Sidorov, $NaCl$, $(NaCl)_2$, $NaCl)_3$ gases.

2. Mass Spectrometric and Thermodynamic Study of Gaseous Species in the Vaporization of Alkali Metal Fluorides and Hydroxides from Pure and Mixed Condensed Phases, Richard C. Schoonmaker, Cornell University, Ithaca, N. Y., University Microfilms, Ann Arbor, L.C. Card No. Mic 60-885. Dissertation Abstracts, 20, 3972-3 (1960).

NaF	$(NaF)_2$	$NaLiF_2$	$(NaF)_3$
LiF	$(LiF)_2$		$(LiF)_3$
NaOH	$(NaOH)_2$	$NaLi(OH)_2$	$(NaOH)_3$
LiOH	$(LiOH)_2$		
$Na_2(OH)F$		$Li_2(OH)Cl$	

3. Molecular Association in Alkali Halide Vapors, S. Datz, AEC Report ORNL-2933, May 1960.

F. Titanium Compounds

1. See Reference A.4., Semenkovich, TiC, TiO_2.

2. Thermodynamics of Titanium Boride, C.A. 55, 91 (1961), A. N. Krestovnikov and M. S. Vendrikh, Izvest. Vysshikh Ucheb. Zavedenii, Tsvetnaya Met. 2, No. 2, 54-7 (1959).

Available in English as Henry Brutcher translation #673.

Vibrational frequencies, heat capacity, entropy and heat of formation and free energy of formation are given for TiB_2.

3. Thermodynamic Properties of TiC at High Temperatures, S. Fujishiro and N. A. Gokcen, J. Phys. Chem. 65, 161-163 (1961).

   The heat of sublimation of Ti(g) from TiC(c) was determined.

G. Carbon

1. Thermodynamic Properties of C_2, Robert L. Altman, J. Chem. Phys. 32, 615-6 (1960)

   ΔH (sublimation) is given for C_2 as well as other properties.

H. Boron Compounds

1. Determination of the Enthalpy of Formation of Boron Trichloride, G. L. Galchenko, B. I. Timofeev, S. M. Skuratov, Zhur. Neorg. Khim. 5, 2645 (1960).

   Amorphous boron was burned in chlorine to form liquid or gaseous BCl_3. $\Delta Hf(g) = -97.0 \pm 0.7$ kcal/mole.

2. Determination of the Enthalpy of Formation of Boron Nitride, G. L. Galchenko, A. N. Kornilov and S. M. Skuratov, Zhur. Neorg. Khim. 5, 2651 (1960).

   Amorphous boron was burned in nitrogen to form BN. $\Delta Hf = -60.7 \pm 0.34$ kcal/mole.

3. See Reference F.2., Krestovnikov and Vendrikh, TiB_2 thermodynamic properties.

4. See Reference A.2., Barrow, Dissociation energy of BCl.

I. Zirconium Compounds

1. W. N. Hubbard, Private Communication.

   The heat of formation of $ZrF_4(c)$ is -456.78 ± 0.25 kcal/mole, determined by direct combustion of the metal in fluorine.

2. Heats of Formation of Zirconium Hydrides, T.B. Douglas, Private Communication.

The following values for heats of formation were derived from previous work on the zirconium-hydrogen system. See Part III.2. of this report for a discussion, and Appendix B for tables of thermodynamic functions. These compositions represent solid solutions but do not correspond to definite compounds.

Composition	$\Delta H_{f298.15}^{\circ}$ kcal/mole Zr
$ZrH_{0.25}$	-5.30 ±0.1
$ZrH_{0.50}$	-10.61 ±0.1
$ZrH_{0.75}$	-15.91 ±0.1
$ZrH_{1.00}$	-21.22 ±0.2
$ZrH_{1.25}$	-26.52 ±0.2

J. Fluoride

1. Relations Between the Thermodynamic Functions of Hydration of Electrolytes, B. Jakuszewski, Lodz. Towarz. Nouk. Wydzial III, No. 4, 1-15 (1960) in English.

   ΔHf and ΔFf of $F^-(g)$ are estimated.

III. 2. THERMODYNAMIC FUNCTIONS OF SOME TITANIUM AND ZIRCONIUM COMPOUNDS. REVISION OF THERMODYNAMIC FUNCTIONS OF LITHIUM AND LITHIUM CHLORIDE.

III 2a. ANALYSIS OF LOW-TEMPERATURE HEAT CAPACITIES AND SMOOTH-JOINING WITH HIGH-TEMPERATURE ENTHALPY MEASUREMENTS

George T. Furukawa and Martin L. Reilly

Analysis and computation of thermodynamic functions below about 400°K discussed in National Bureau of Standards Reports 6297 and 6484 dealt with lithium, beryllium, magnesium, aluminum and their compounds with hydrogen, oxygen, nitrogen, fluorine, and chlorine. The results of these analyses were joined smoothly with the available thermodynamic functions at higher temperatures. In NBS Report 6645 and 6928, the survey of thermodynamic data on the carbides and nitrides of elements belonging to the first and second rows of the periodic table was presented along with thermodynamic functions analyzed and computed for Ti, TiC and TiN. In this report the analysis and computation of thermodynamic functions of other titanium compounds and of zirconium metal and zirconium compounds are given. The thermodynamic functions tabulated in the earlier reports for Li and LiCl have been revised in light of new data that have become available. The methods of analysis and calculation of thermodynamic functions are the same as those described in NBS Report No. 6484. The low-temperature values of heat capacity were joined smoothly with the high-temperature values derived from the enthalpy equations that were selected. (See Part III. 2.b.) In the process the lower temperature limit of applicability of the enthalpy equation was in general raised from 298.15°K to about 400°K. The experimental or tabular values of enthalpy, which are considered to be more accurate than the equation values, were used to guide the smoothing process.

Lithium, Li, 6.940

Measurements of the low-temperature heat capacity of lithium reported by Simon and Swain [23] (15° to 300°K) do not show continuity with the heat-capacity values derived from the enthalpy measurements in the range 0° to 900°C reported by Douglas, Epstein, Dever, and Howland [6]. The tables of thermodynamic functions given in the earlier NBS reports (6297, 6484, and 6928) on lithium were based on certain adjustments made to the data given by Simon and Swain [23]. Recently Martin [15] completed a series of heat-capacity measurements (20° to 300°K) on lithium and obtained results in close agreement with the adjusted values. A martensitic transformation observed by Martin [15] was, however, not considered in the earlier NBS reports. The new results reported by Martin [15] were joined smoothly with those reported earlier by Roberts [19] (1.5° to 20°K) and by Douglas, Epstein, Dever, and Howland [6] and a revised table of thermodynamic functions has been calculated from the results of the analysis. Earlier measurements by Koref [14] (-192° to 19°C) and by Dewar [4] (20° to 80°K) were not considered in the values finally selected.

Lithium Chloride, LiCℓ, 42.397

Low-temperature thermodynamic properties of LiCℓ given in NBS Report No. 6297, 6484, and 6928 were based on rather scattered data reported by Slonim and Hüttig [25] (-188° to 96°C). Recently, Hatton, Sinke, and Stull [11] (12° to 323°K) and Shirley [20] (15° to 325°K) reported new measurements. The results of Hatton, Sinke, and Stull [11] are lower than those of Shirley [20] below about 60°K and higher above this temperature. In the upper range, the two results differ by about two percent. These results were combined and joined smoothly with the high-temperature enthalpy measurements made by Douglas, Harman, and Dever [7] (0° to 900°C). A revised table of thermodynamic properties has been calculated from the results.

Titanium Monoxide, TiO, 63.90

Shomate [21] (52° to 296°K) determined the low-temperature heat capacity of titanium monoxide prepared by heating equimolal amounts of TiO_2 and titanium metal at 1350°C in vacuum. The reported analysis of the sample was 99.2 percent TiO, 0.1 percent TiC, and 0.7 percent silicon. Naylor [17] (298° to 1770°K) reported measurements of the enthalpy relative to 298°K of a sample of TiO having the same analysis as the sample used by Shomate [21]. These two measurements were joined smoothly and combined with heat-capacity values below 50°K obtained from the Debye-Einstein heat-capacity equation $C = D\,(437/T) + E\,(653/T)$ given by Shomate [21].

Titanium Sesquioxide, Ti_2O_3, 143.80

Low-temperature heat-capacity measurements were reported by Shomate [21] (53° to 296°K). The sample was prepared in vacuum at 1350°C by reducing a finely-ground mixture of TiO_2 and carbon according to the reaction:

$$2\,TiO_2 + C \rightarrow Ti_2O_3 + CO.$$

The analysis reported for this product was 99.4 percent Ti_2O_3, 0.3 percent TiC, and 0.3 percent SiO_2. X-ray diffraction measurements indicated the product to have a structure similar to Fe_2O_3. High-temperature measurements reported by Naylor [17] (298° to 1750°K) were made on the same sample. These results were combined with the Debye-Einstein heat-capacity equation

$$C = 2D\,(441/T) + 3E\,(663/T)$$

given by Shomate [21] to obtain smooth values of heat capacity down to 0°K.

Titanium Tritapentoxide, Ti_3O_5, 223.70

Shomate [21] (53° to 297°K) measured the low-temperature heat capacity of Ti_3O_5. The sample was prepared by reducing TiO_2 with carbon according to the reaction:

$$3TiO_2 + C \rightarrow Ti_3O_5 + CO,$$

by heating a finely-ground mixture in vacuum at 1350°C. Analysis of the product yielded 99.1 percent Ti_3O_5, 0.2 percent TiC, and 0.7 percent SiO_2. X-ray pattern did not indicate presence of TiO_2 or Ti_2O_3. Naylor [17] (298° to 1340°K) measured the relative enthalpy of the same sample above room temperature. The results show a transition at about 450°K. When the material was heated above this temperature it did not return to the original state on subsequent cooling. The measurements below 450°K were separated into two groups for analysis, those made before heating above 450°K and those made after heating above this temperature. The low-temperature measurements of Shomate [21] were joined with the high-temperature measurements of Naylor [17] obtained before heating above 450°K, and combined with Debye-Einstein heat-capacity equation

$$C = 3D\ (399/T) + 5E\ (654/T)$$

given by Shomate [21] to obtain values of heat capacity down to 0°K. The measurements above 450°K were adjusted in accordance with the results that were obtained on the sample below 450°K after heating above this temperature.

Titanium Dioxide (Rutile), TiO_2, 79.90

Low-temperature heat-capacity measurements on rutile have been reported by McDonald and Seltz [16] (68° to 298°K); Shomate [22] (52° to 298°K); Dugdale, Morrison, and Patterson [9] (12° to 270°K); and Keesom and Pearlman [12] (1° to 20°K). Heat measurements above room temperature have been reported by Nilson and Pettersson [18] (273° to 713°K) and by Naylor [17] (298° to 1746°K). Measurements on TiO_2 reported by Arthur [1] (295° to 1072°K) do not give information on the crystalline nature of the sample; thus they were not considered in the analysis. Measurements of Keesom and Pearlman [12] were on a synthetic single crystal TiO_2 and those of Naylor [17] were on naturally occurring rutile that gave a chemical analysis of 97.90 percent TiO_2. Other investigators used polycrystalline samples of rutile. Although Dugdale, Morrison, and Patterson [9] made measurements over the range 12° to 270°K, numerical values were available in their publication for the range 20° to 50°K only. Results reported by Shomate [22]; Dugdale, Morrison, and Patterson [9]; Keesom and Pearlman [12]; and Naylor [17] were combined to obtain smooth values of heat capacity.

Titanium Dioxide (Anatase), TiO_2, 79.90

Shomate [22] (52° to 296°K) reported low-temperature measurements on anatase. Naylor [17] (298° to 1350°K) reported enthalpy measurements above room temperature. The sample investigated by Shomate [22] was prepared by dissolving high-purity titanium metal in 6-N hydrochloric acid and precipitating with 50-percent KOH. The precipitated TiO_2 was washed, redissolved in HCl, and reprecipitated with NH_4OH. The material was washed, dried at 400°C in vacuum, ground, rewashed, and finally redried at 550°C in vacuum. The analysis reported for the sample was 99.3 percent TiO_2. The sample investigated by Naylor [17] was purchased from J. T. Baker. After drying for 4 hours at 1050°C, the material was analyzed and found to contain 0.30 percent SiO_2 and 0.15 percent CaO. X-ray diffraction measurements showed the material to be anatase. Naylor [17] made measurements actually to 1773°K. X-ray examination of the sample removed from the capsule following the measurements showed, however, that the material had become rutile. Since the four-hour heating at 1050°C did not cause measurable conversion to rutile, Naylor [17] reported only those data obtained below 1050°C.

The results of these two measurements were combined to obtain smoothed values of heat capacity. The values below about 52°K were obtained from the Debye-Einstein heat-capacity function $C = D\ (343/T) + E\ (497/T) + E\ (950/T)$ given by Shomate [22].

Zirconium, Zr, 91.22

Measurements of the low-temperature heat-capacity have been reported by Todd [26] (53° to 297°K); Skinner and Johnston [24] (14° to 298°K); Estermann, Friedberg, and Goldman [10] (1.8° to 4.2°K); Wolcott [27] (1.2° to 20°K); and Burk, Estermann, and Friedberg [2] (20° to 200°K). The sample investigated by Estermann, Friedberg, and Goldman [10] and by Burk, Estermann, and Friedberg [2] is indicated to be 99.5 percent or better. The sample studied by Todd [26] contained among other impurities 2.15 percent of hafnium. A correction of + 1.0 percent was applied assuming zirconium and hafnium to have the same molal heat capacity. Skinner and Johnston's sample [24] contained 0.67 mole percent iron plus 0.28 mole percent of other impurities. The results of Todd [26] and Burk, Estermann, and Friedberg [2] are in close agreement, while those obtained above 130°K by Skinner and Johnston [24] are about 1 percent lower. The sample studied by Wolcott [27] contained about 1 percent of hafnium. Results of these measurements were combined to join smoothly with the high-temperature enthalpy equation:

$$H_T - H_{298.15} = 5.334\ T + 1.2935\ (10^{-3})\ T^2 - 1705.3$$

derived by Douglas [5] on the basis of experimental data at high temperatures (see III 2b below).

Zirconium Dioxide, ZrO_2, 123.22

Measurements of the low-temperature heat capacity were made by Kelley [13] (54° to 295°K). Heat measurements above room temperature were made by Arthur [1] (293° to 1265°K) and by Coughlin and King [3] (298° to 1080°K). Values of heat capacity obtainable from the equation given by Arthur [1] are as much as 5 percent lower in the 300°K range than the values of the low-temperature measurements. Since the results of Kelley [13] and of Coughlin and King [3] are in close agreement they were joined smoothly and the results of Arthur [1] were not considered. The values of heat capacity below 54°K were obtained using the Debye-Einstein heat-capacity equation $C = D(345/T) + E(513/T) + E(861/T)$ given by Kelley [13].

Zirconium Nitride, ZrN, 105.228

Low-temperature heat-capacity measurements on zirconium nitride (ZrN) were reported by Todd [26] (53° to 297°K). The material was prepared by treating a mixture, that initially contained 94.8 percent ZrN and 5.2 percent ZrH_2, with a stream of nitrogen and hydrogen of 3 to 1 ratio at 1250°C. Subsequently, the material was heated in vacuum at 1250°C. Hafnium content was estimated to be 1.35 percent. A correction of + 0.7 percent was applied, assuming that the corresponding hafnium compound (HfN) would have the same molal heat capacity. The high-temperature measurements reported by Coughlin and King [3] (298° to 1672°K) were made on the same sample. Results of these two measurements were combined with the Debye-Einstein heat-capacity equation:

$$C = D(360/T) + E(673/T)$$

given by Todd [26] to obtain smooth heat-capacity values down to 0°K.

Zirconium Tetrachloride, $ZrCl_4$, 233.048

Low-temperature heat-capacity measurements on zirconium tetrachloride ($ZrCl_4$) have been reported by Todd [26] (52° to 297°K) and the high-temperature measurements on the same sample by Coughlin and King [3] (298° to 567°K). The material was prepared by treating a mixture of carbon black and ZrO_2 with chlorine at 500°C. The sublimed $ZrCl_4$ was purified by resublimation. The sample was estimated to contain 0.75 percent of hafnium. A correction of + 0.35 percent has been applied assuming that the molal heat capacity of the corresponding hafnium compound ($HfCl_4$) would be the same. These results were combined with the Debye-Einstein heat-capacity equation:

$$C = D(73.0/T) + 2E(167/T) + 2E(414/T)$$

given by Todd [26] to obtain smooth values of heat capacity down to 0°K.

III 2b. THERMODYNAMIC FUNCTIONS AT HIGH TEMPERATURES

Thomas B. Douglas and Andrew C. Victor

Titanium Oxides (TiO, Ti_2O_3, Ti_3O_5, TiO_2 (Rutile), TiO_2 (Anatase)), Zirconium (Zr), Zirconium Dioxide (ZrO_2), Zirconium Nitride (ZrN), Zirconium Tetrachloride ($ZrCl_4$)

The tables for these nine substances are based on enthalpy-temperature data determined by both low- and high-temperature methods. In most cases the temperature ranges covered by the two methods overlap somewhat (near room temperature). The enthalpy-temperature functions on which the tables are based were smoothed in the respective overlap regions by relatively weighting the competing data according to their apparent relative reliability. (The details are discussed in this chapter under each substance.) For every substance except zirconium (discussed below), the enthalpy-temperature functions were taken from Kelley's recent publication [28]. As indicated earlier (III 2a), the lower temperature limits of applicability of these equations have been raised somewhat (i.e., to above 298.15°K) in the process of smooth-joining.

Zirconium (Zr)

High-temperature enthalpy data taken into consideration have been reported by Coughlin and King (298°-1371°K) [3], Douglas and Victor (273°-1173°K) [8], Jaeger and Veenstra (294°-1074°K) [29], Redmond and Lones (273-1309°K) [30], Scott (363°-1223°K) [31], and Skinner (298°-1800°K) [32]. The data of Douglas and Victor were determined on a sample whose analysis indicated high purity, their data have the vest overall precision in their temperature range, and their heat-capacity curve joins smoothly with the low-temperature curve of Todd [26], but not with that of Skinner and Johnston [24], which is somewhat lower near room temperature. Skinner [32] has argued that the heat-capacity curves of Todd and of Coughlin and King are somewhat too high owing to small amounts of oxygen in their samples. In line with this argument, Douglas and Victor's data indicate a small but definite maximum near 500°K which apparently cannot plausibly be explained in any other way, since it is well established that in zirconium a very small amount of hydrogen, and presumably of oxygen also, produces such an effect owing to the thermal effects of solution and precipitation of slightly soluble solid solutions formed by these impurities. This may be the explanation of the unusually large scatter in the heat capacities reported for zirconium by many authors.

The enthalpy-temperature relation adopted as a compromise in the present report joins smoothly with the average of the low-temperature curves of Todd [26] and of Skinner and Johnston [24] near 298°K, and fits the data of Douglas and Victor [8] from 573° to 1158°K and those of Skinner [32] from 1158° to 1800°K. The enthalpy above 1800°K, the heat of fusion, and the heat capacity of the liquid have been estimated [33]. The following equations represent the adopted high-temperature enthalpy of zirconium (in cal $mole^{-1}$ at T°K) relative to that of α-Zr at 298.15°K:

Alpha (298° - 1136°K): $H^\circ_T - H^\circ_{298.15} = 5.334\ T + 1.2935\ (10^{-3})\ T^2 - 1705.3$

Transition (1136°K): $\Delta H^\circ = 959.5$

Beta (1136° - 2130°K): $H^\circ_T - H^\circ_{298.15} = 4.859\ T + 8.03\ (10^{-4})\ T^2 + 426.8$

Fusion (2130°K): $\Delta H^\circ = 4050$

Liquid (2130° - 3500°K): $H^\circ_T - H^\circ_{298.15} = 9.504\ T - 4.000\ (10^{-4})\ T^2 + 40.9$

Zirconium Hydrides ($ZrH_{0.25}$, $ZrH_{0.50}$, $ZrH_{0.75}$, $ZrH_{1.00}$, $ZrH_{1.25}$)

These hydrides, for which tables of thermodynamic functions are given in this report, are not definite compounds, but representative compositions. This is evident from the Zr-H phase diagram shown in Fig. 19, Appendix A:[a] hydrogen dissolves in zirconium in continuous amounts (but with miscibility gaps as shown) to form brittle metallic-like solid solutions up to a composition approaching ZrH_2. These thermodynamic functions, as well as the standard heats of formation listed elsewhere in this report, were recently calculated from a review paper [34] which critically correlated the available data on various properties of the system. The first-order transition was assumed to be 550°C (823.2°K), but is uncertain by ± 10°. Below the transition temperature the thermodynamic properties vary linearly with the H/Zr ratio; at higher temperatures they do not. Most of the phase boundaries have been determined and checked by a variety of physical methods, and are fairly well established. In some cases, however, such properties as the heat capacity are so sensitive to the exact phase boundaries as to be known only approximately. However, within certain limits the tables form an interconsistent representation of all the best available thermodynamic data.

---

[a] This diagram is identical with that in reference [34], and omits two boundaries above 60 atomic % H for which there is some published evidence. The two dashed boundaries are considerably uncertain. The relative enthalpy was measured several years ago at the National Bureau of Standards [8] at the points shown on the diagram. The phases labeled "γ" have been called "δ" and "ε" by some authors.

It may be noted, however, that decomposition pressures cannot be calculated from the free-energy functions of these tables, since the latter do not include the resulting compositions. For all compositions represented in Fig. 19, Appendix A, the decomposition pressure is negligible at room temperature, but in most cases exceeds one atmosphere above 1200°K.

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Al-B

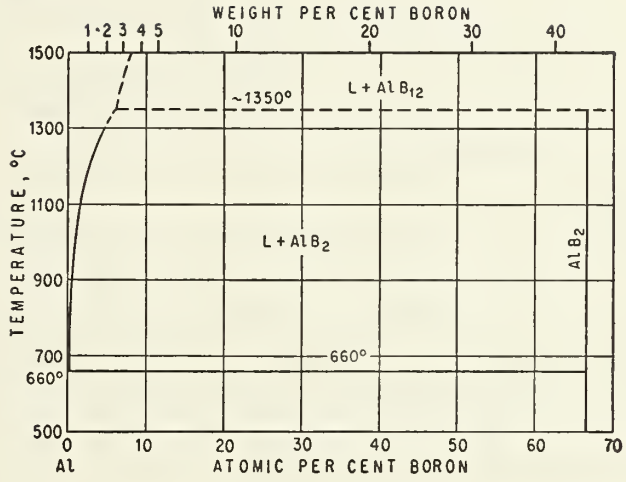

Fig. 1

Al-Be

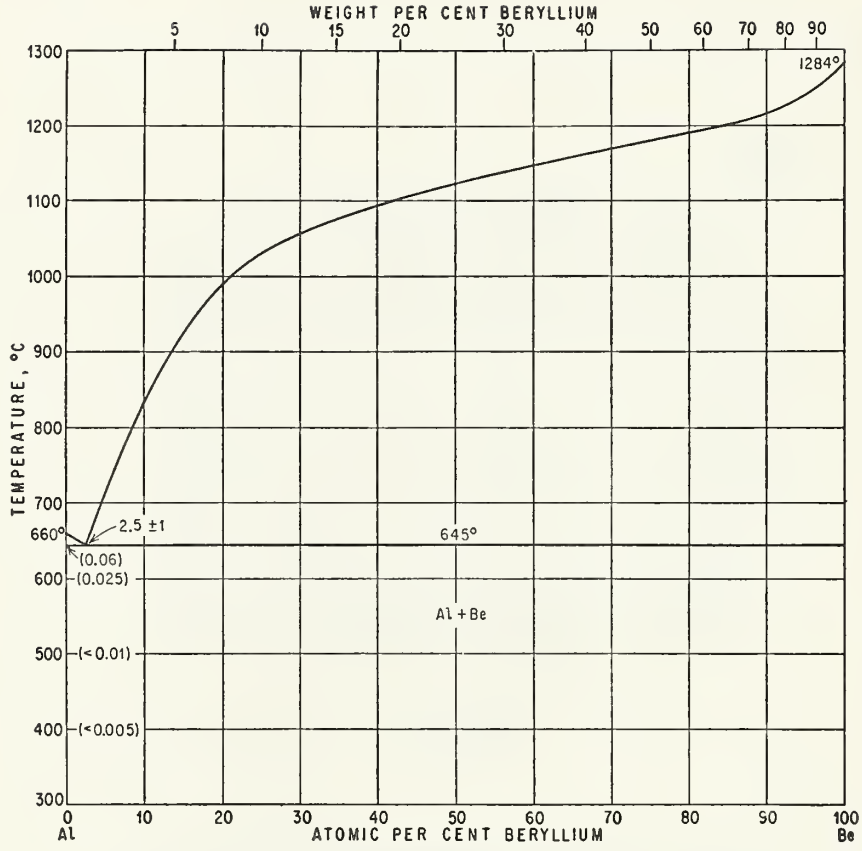

Fig. 2

Al-Li

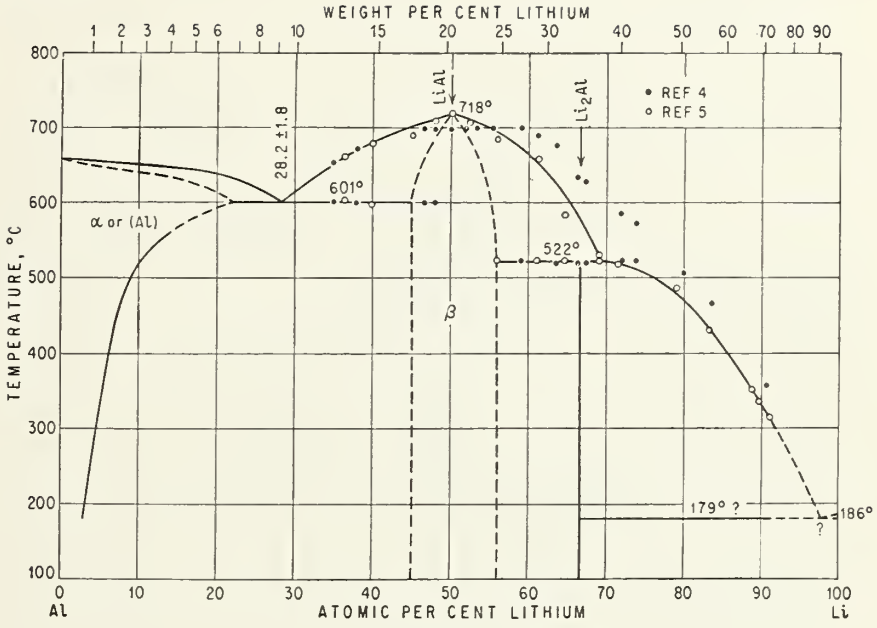

Fig. 3

Aℓ-Mg

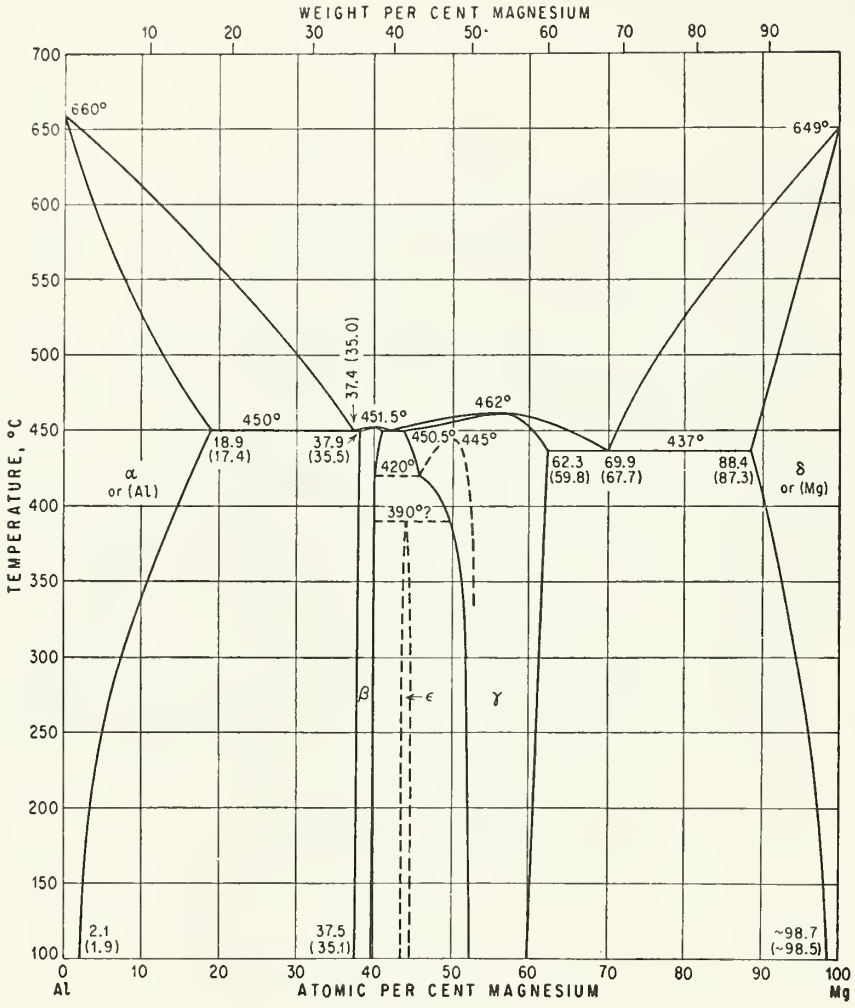

Fig. 4

Al-Si

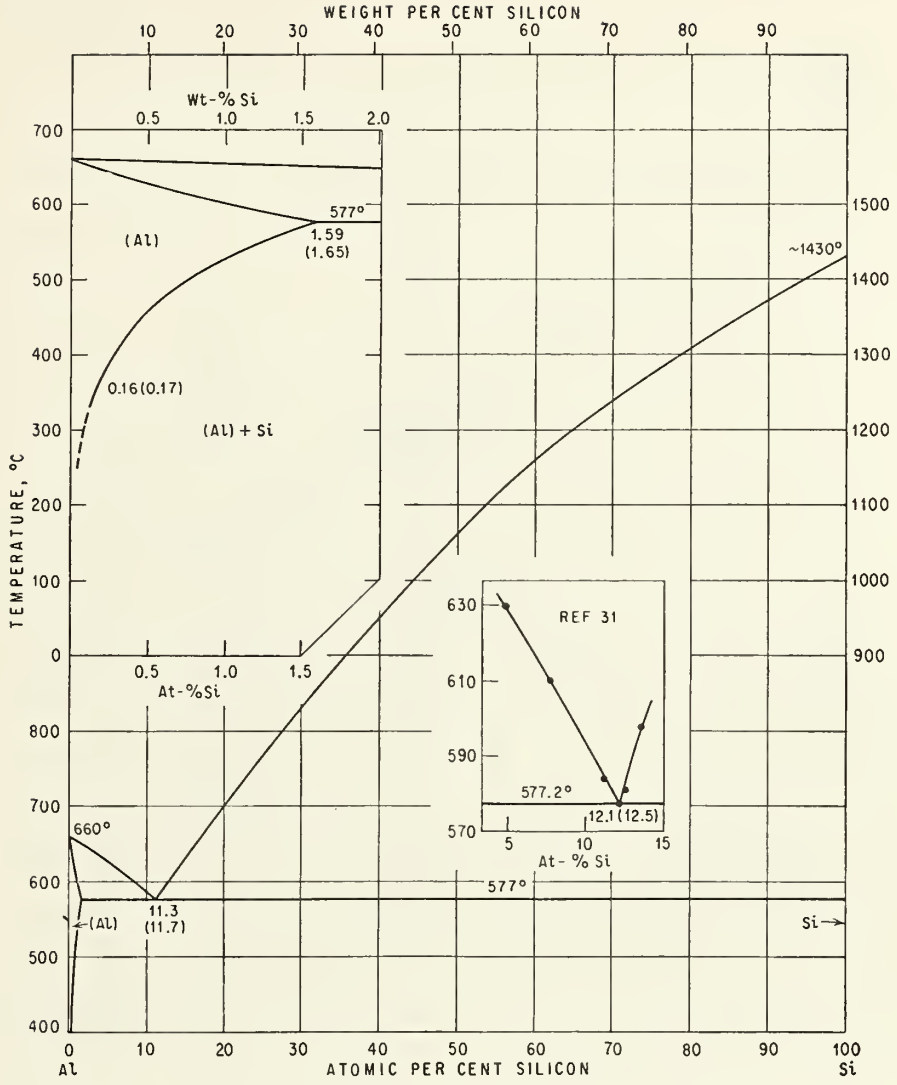

Fig. 5

Al-Ti

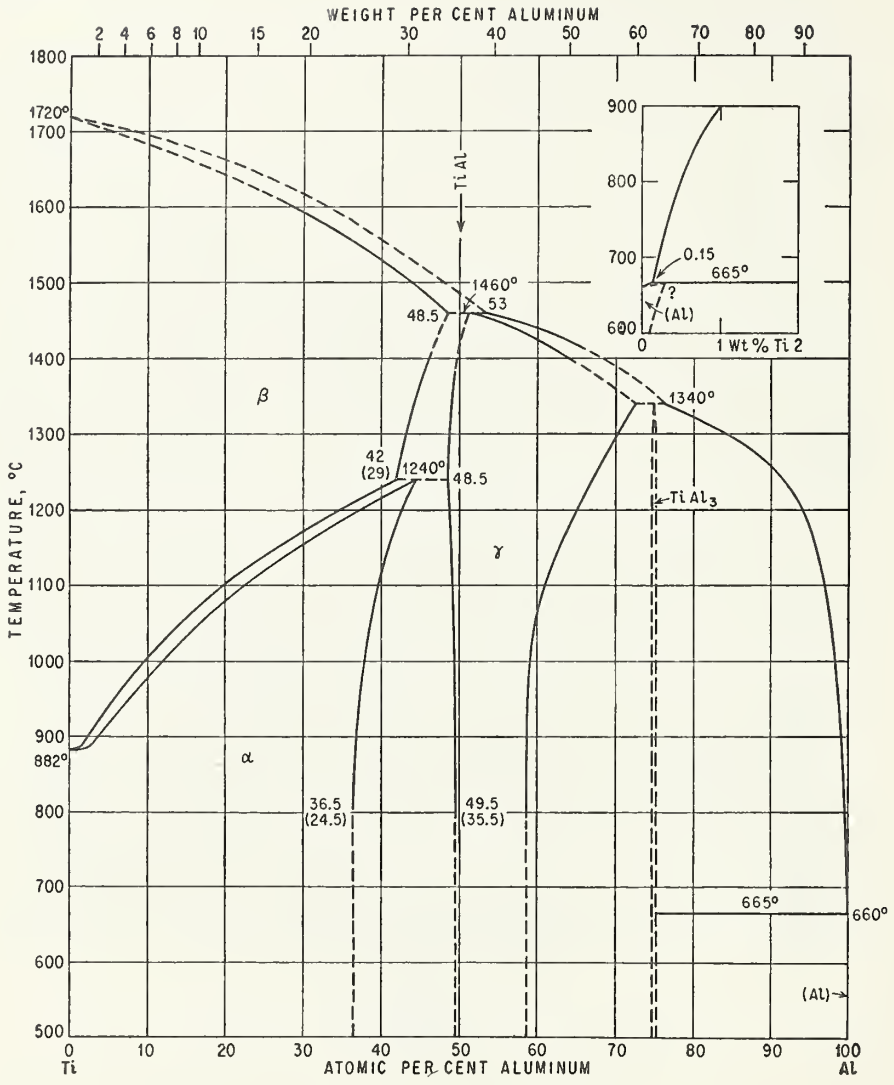

Fig. 6

Al-Zr

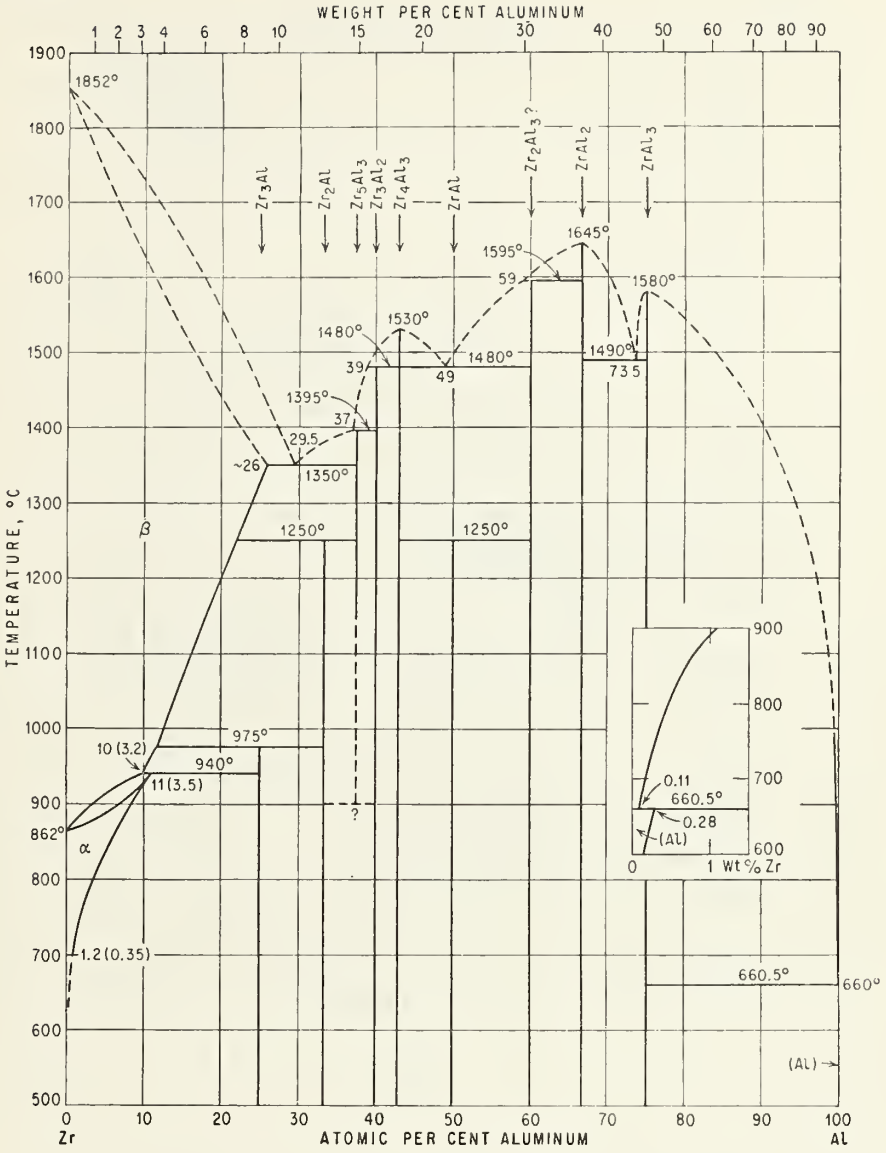

Fig. 7

Ti-B

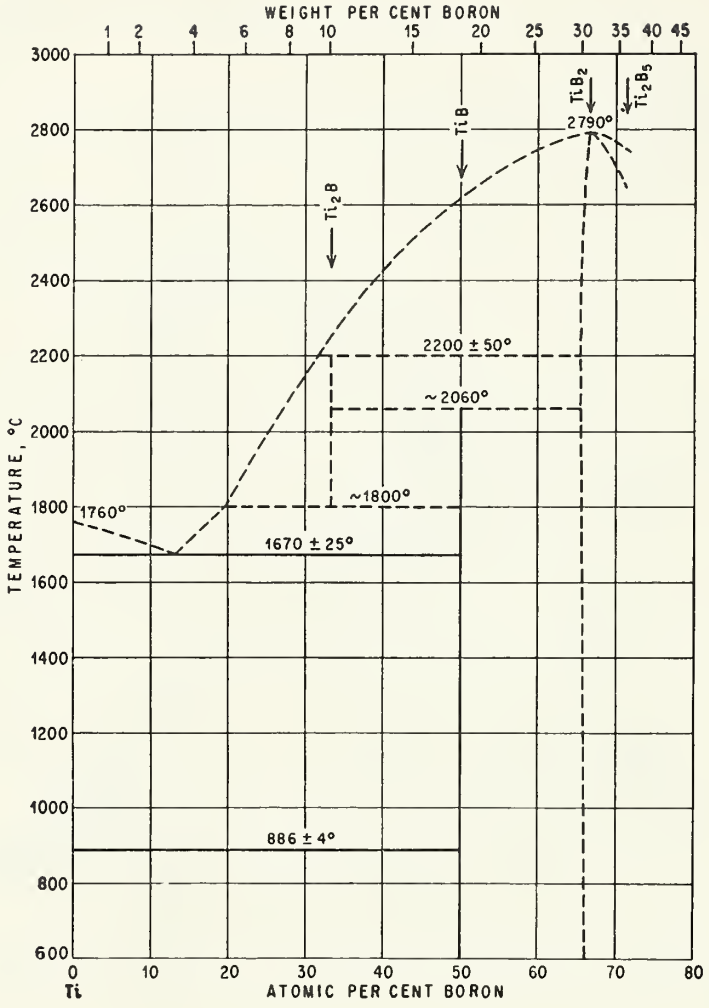

Fig. 8

Zr-B

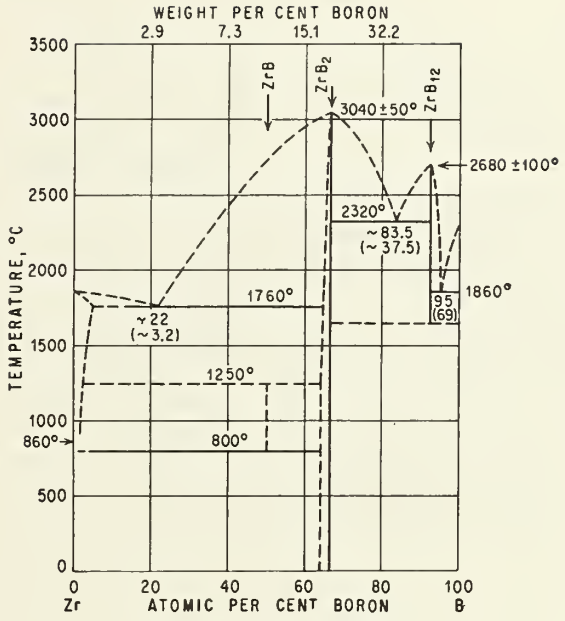

Fig. 9

Be-Si

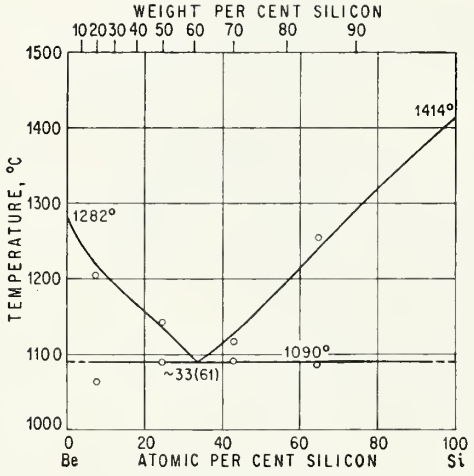

Fig. 10

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Be-Zr

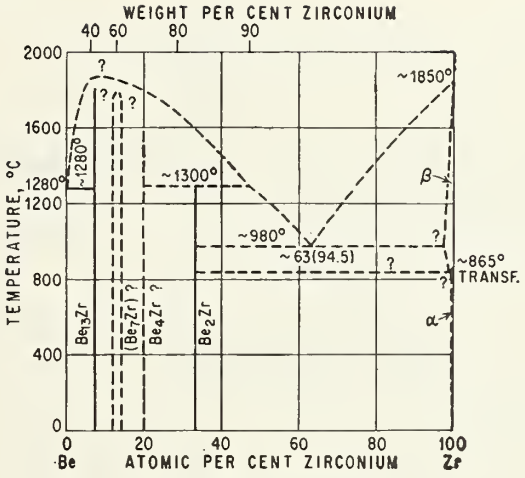


Fig. 11

Li-Mg

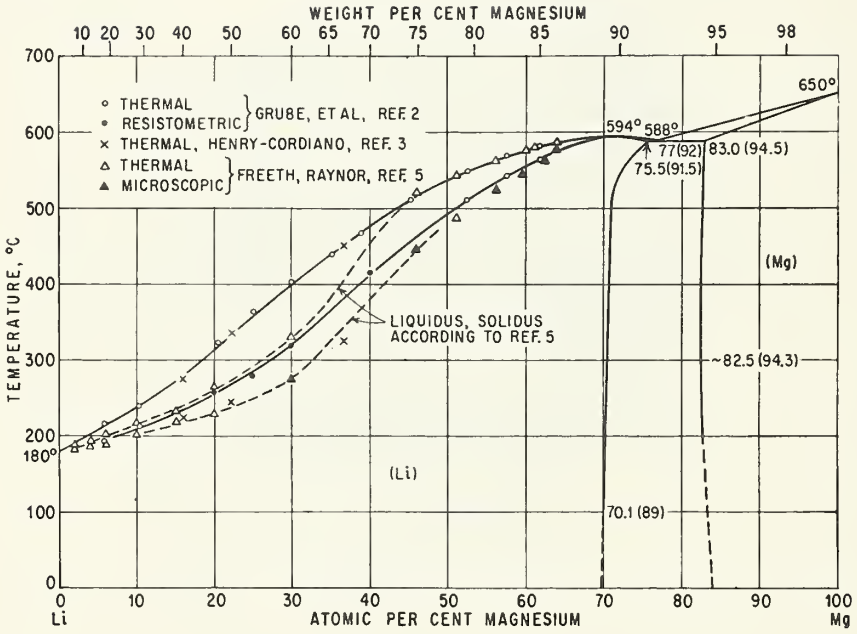


Fig. 12

Mg-Si

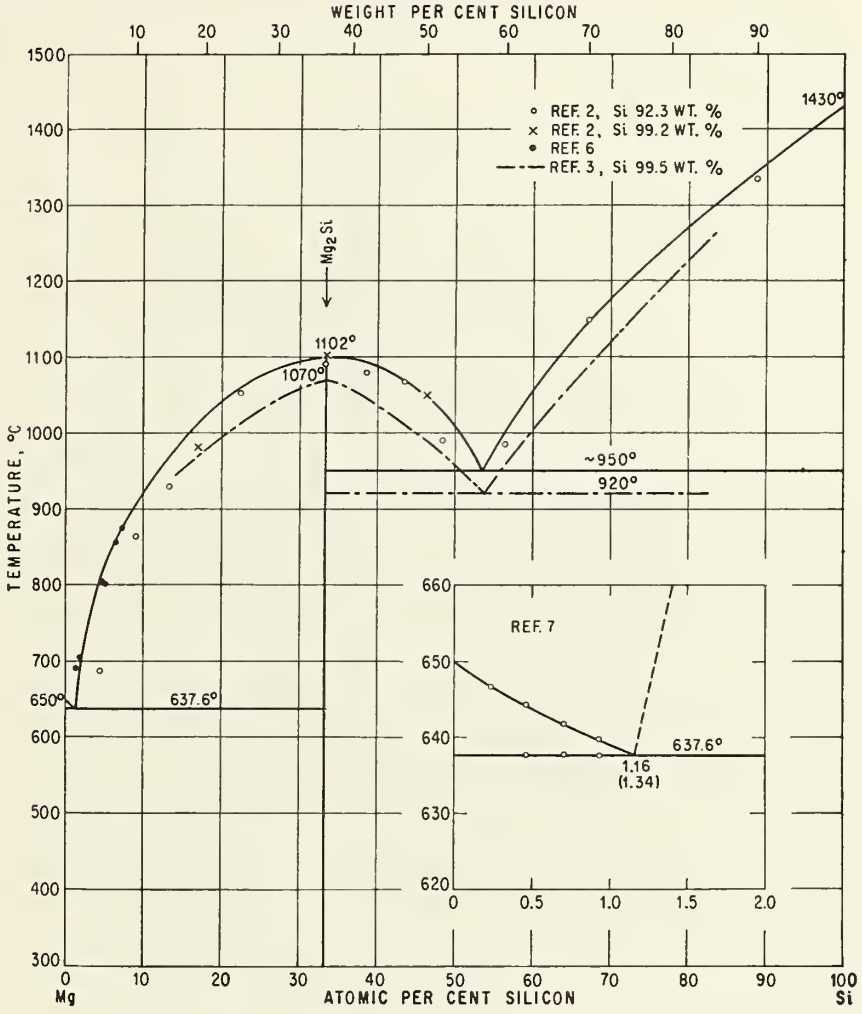


Fig. 13

Mg-Ti

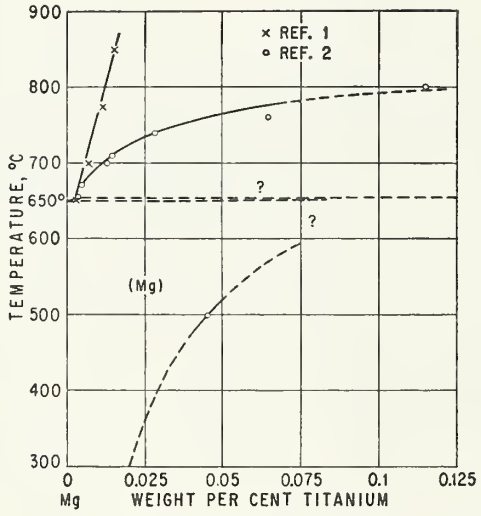


Fig. 14

Mg-Zr

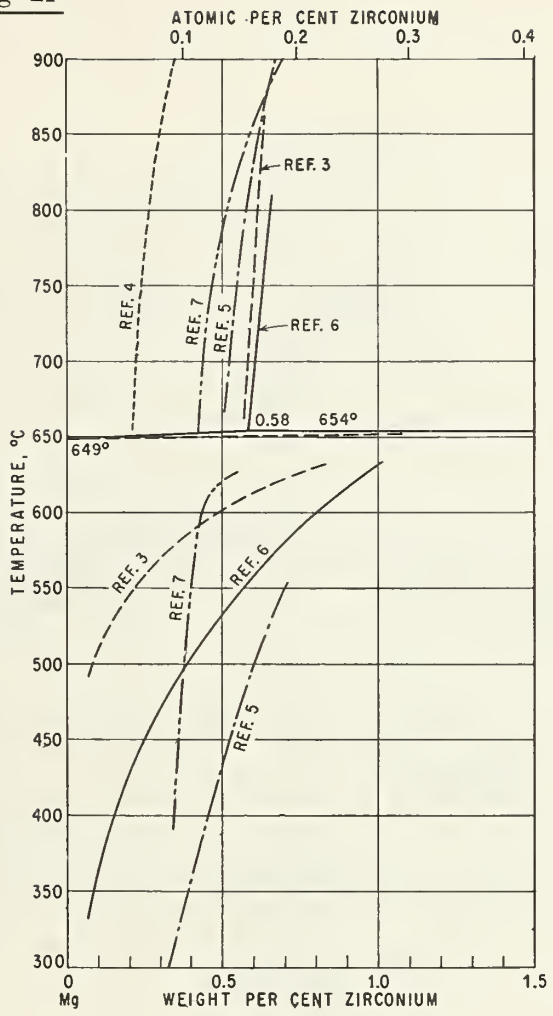


Fig. 15

Ti-Si

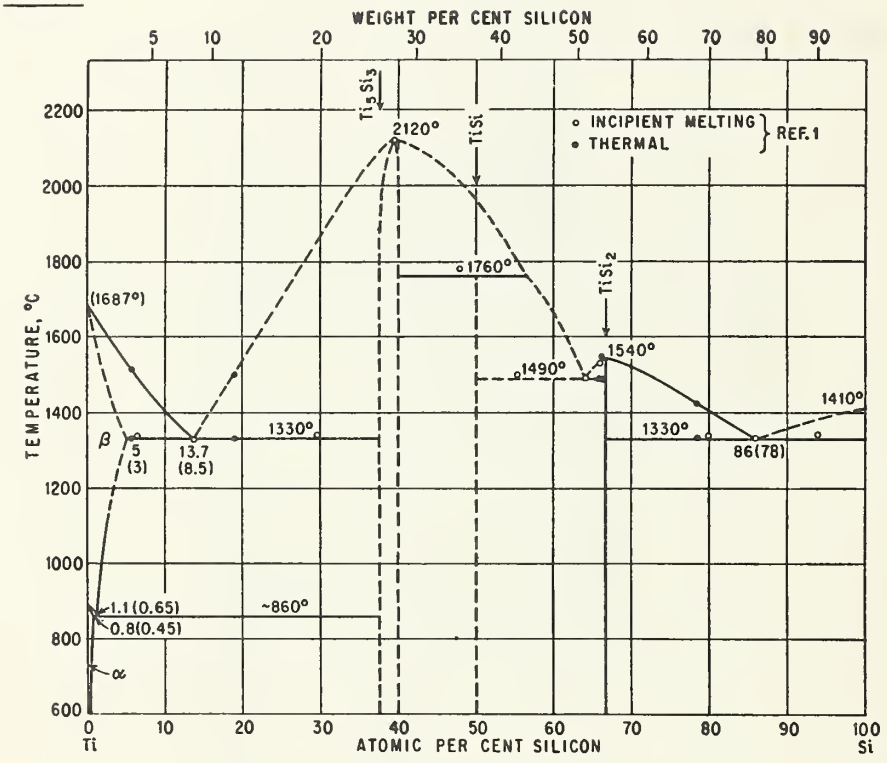


Fig. 16

Zr-Si

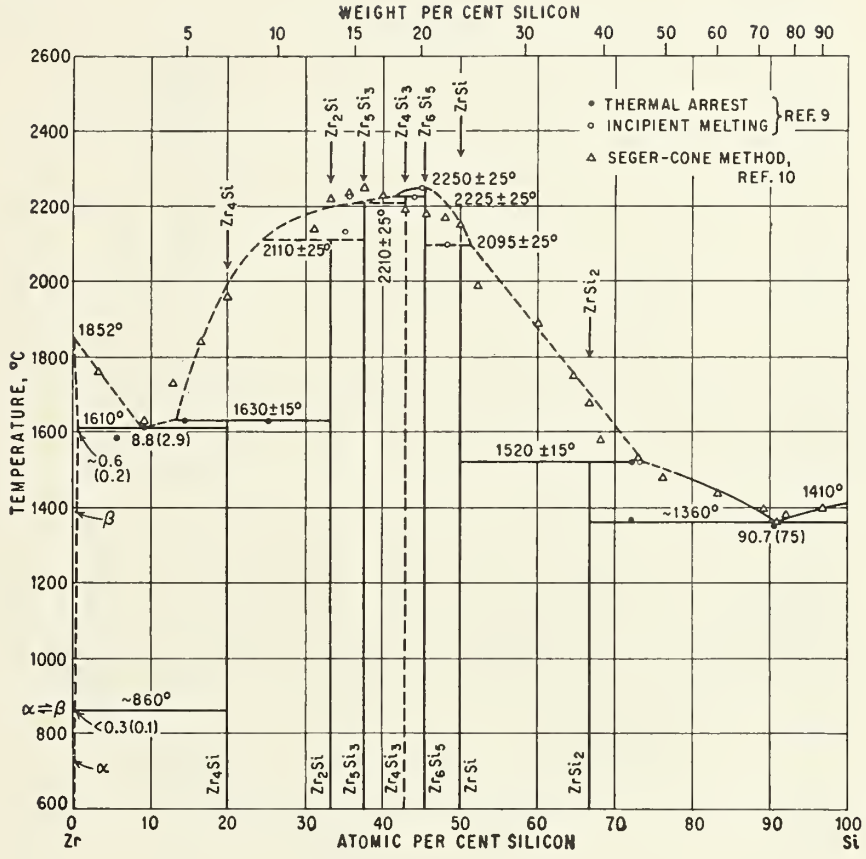


Fig. 17

Ti-Zr

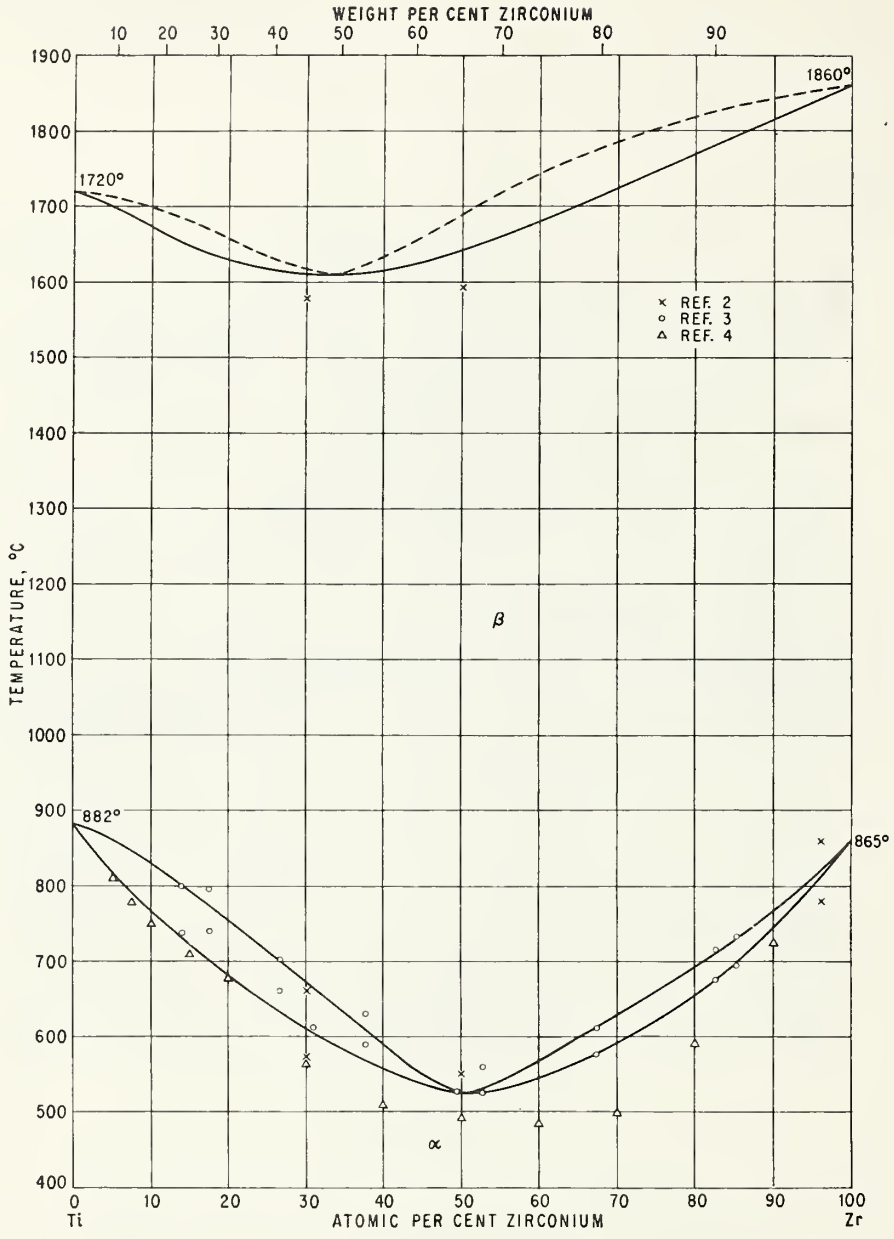
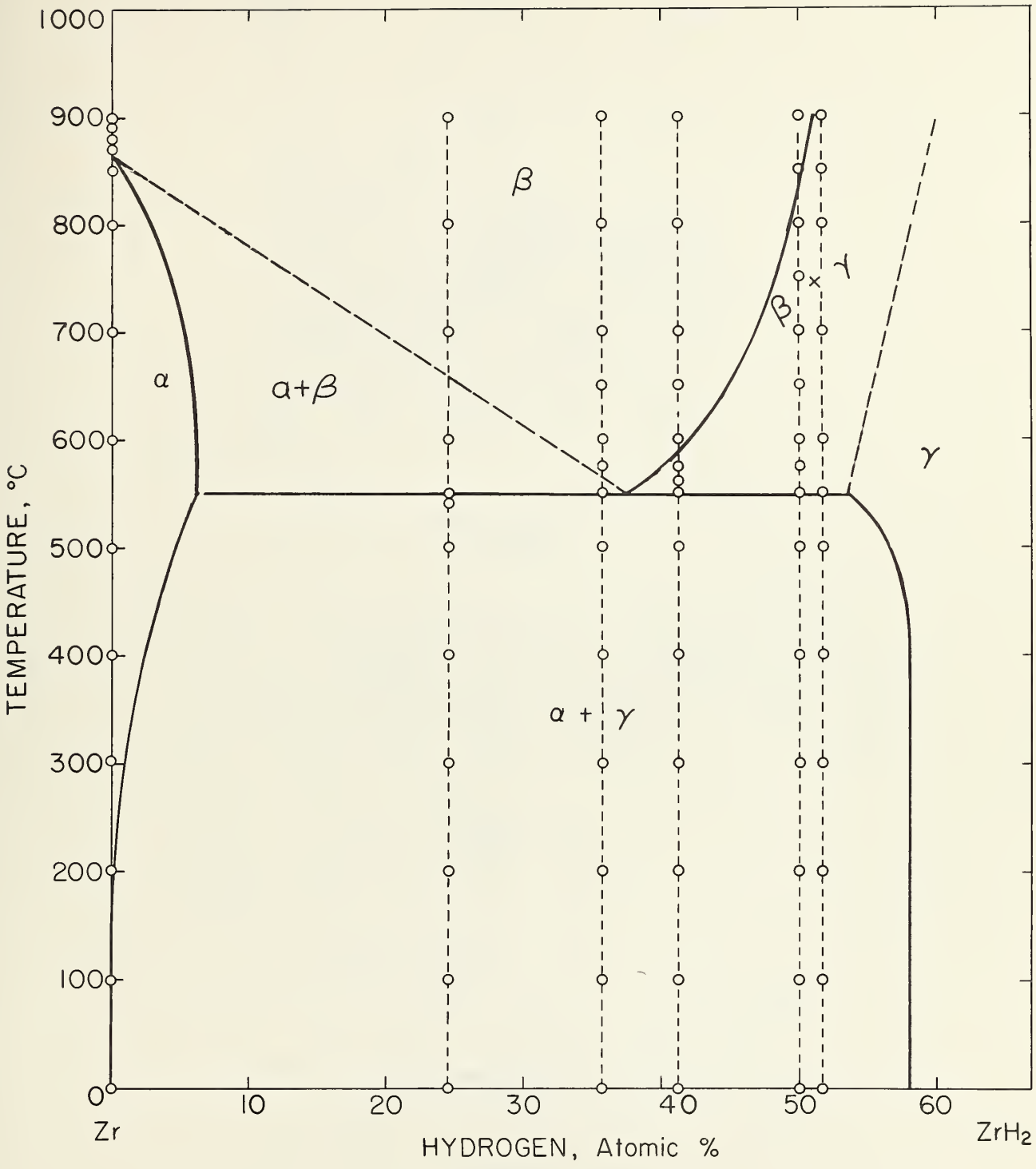


Fig. 18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50
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Zr
ZrH2
HYDROGEN, Atomic %

Fig. 19

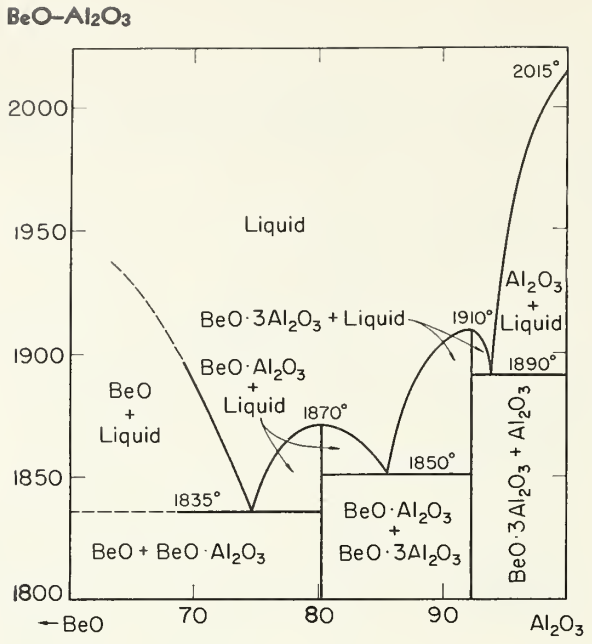

Figure 20

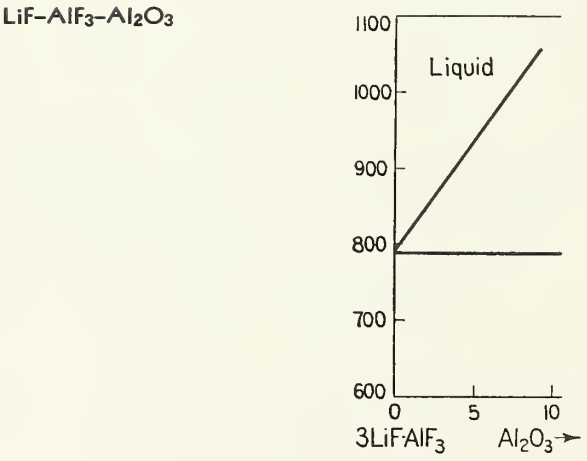

Figure 21

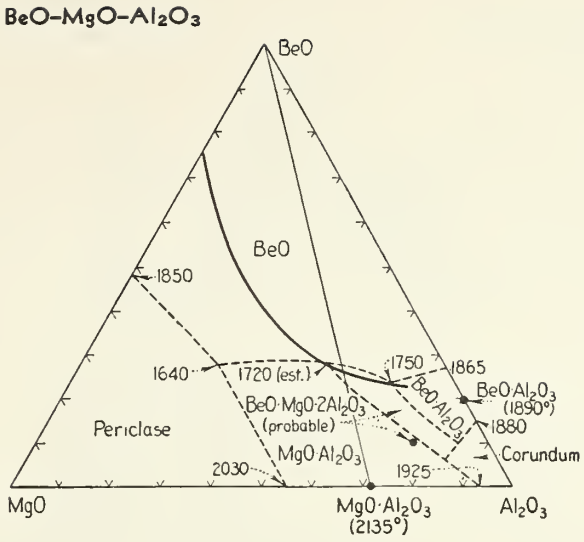

Figure 22

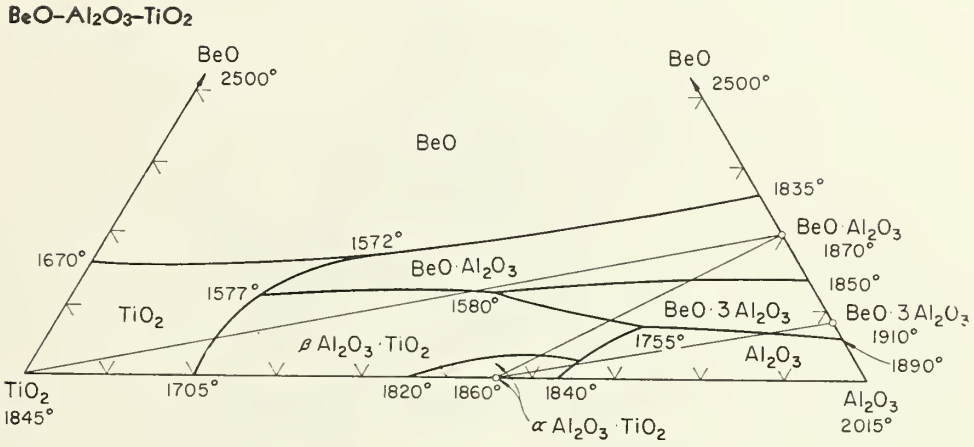

Figure 23

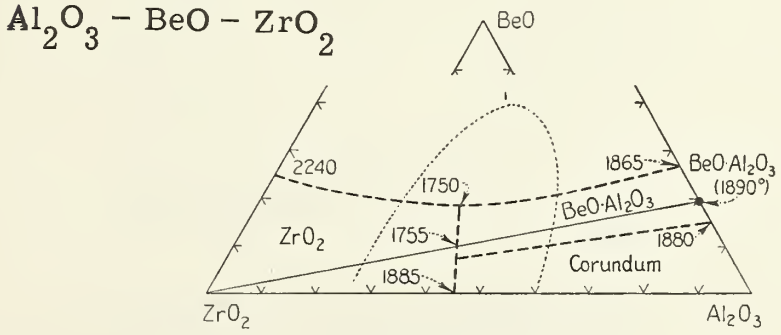

Figure 24

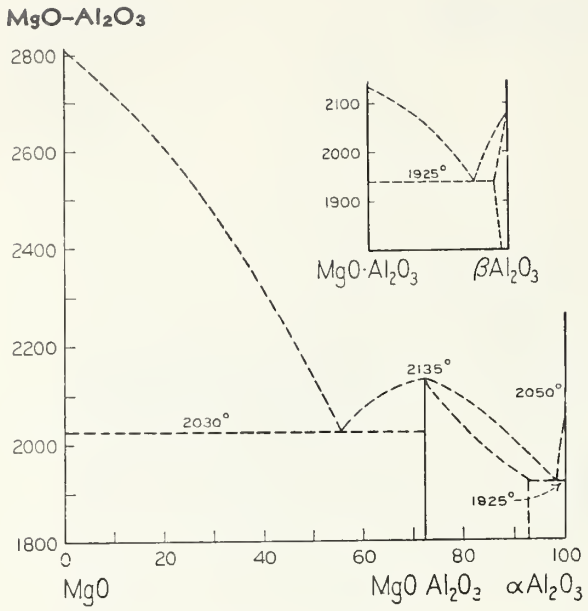

Figure 25

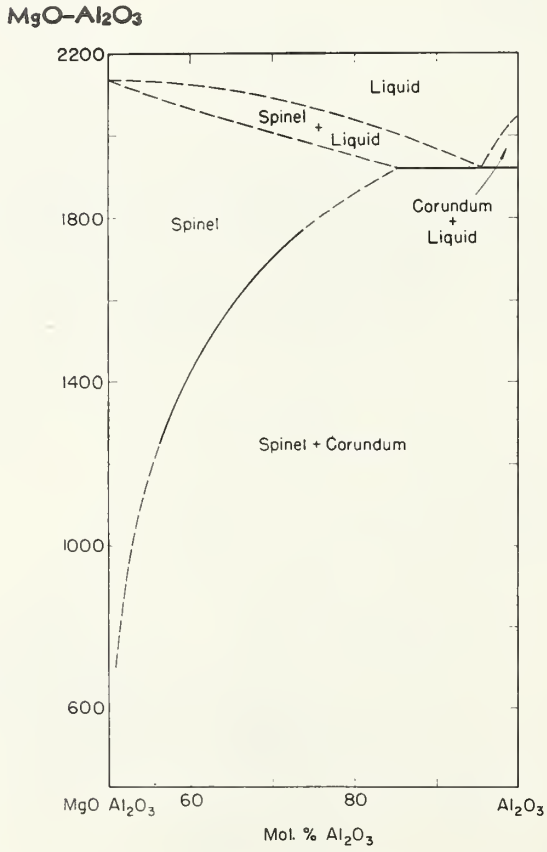

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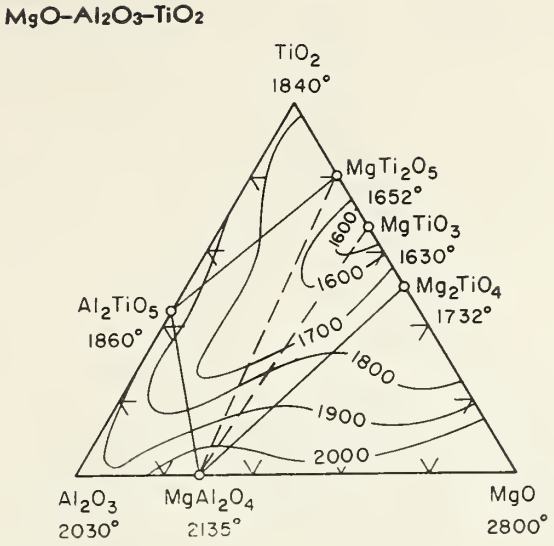
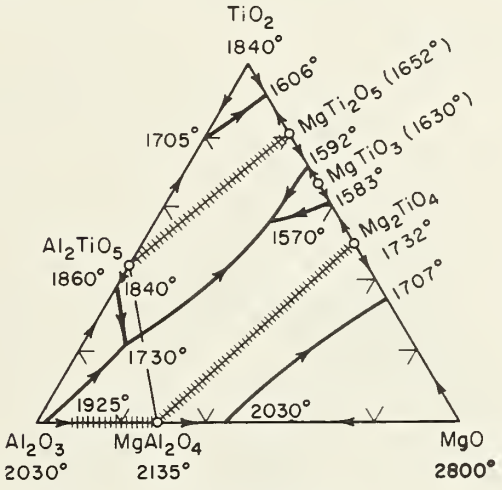
Figure 26



$MgO - Al_2O_3 - TiO_2$ Figure 27



$Al_2O_3 - TiO_2$ Figure 28

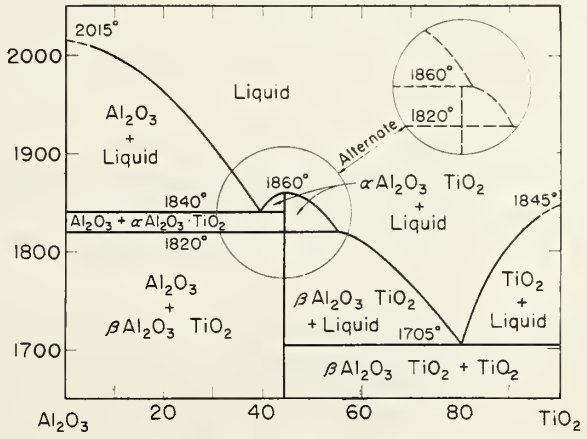


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Figure 29

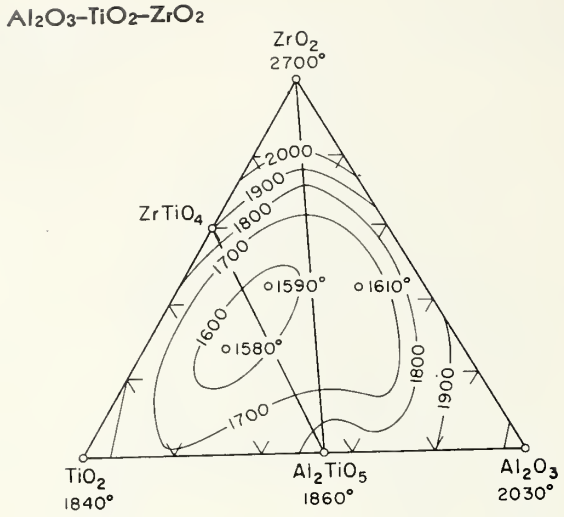

Figure 30

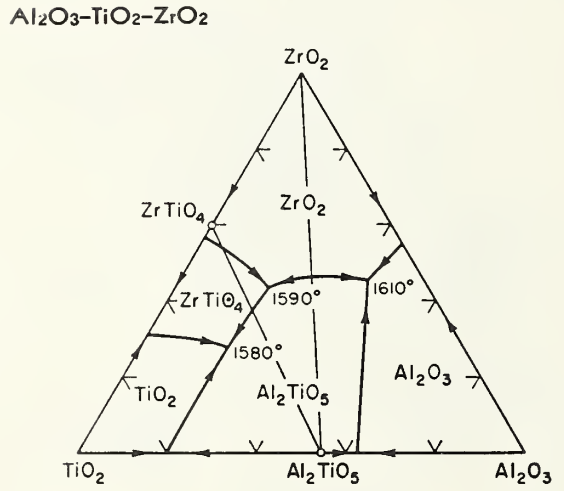

Figure 31

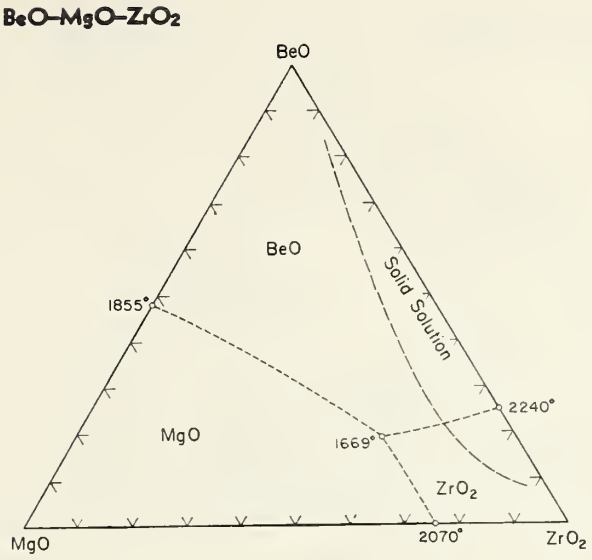

Figure 32

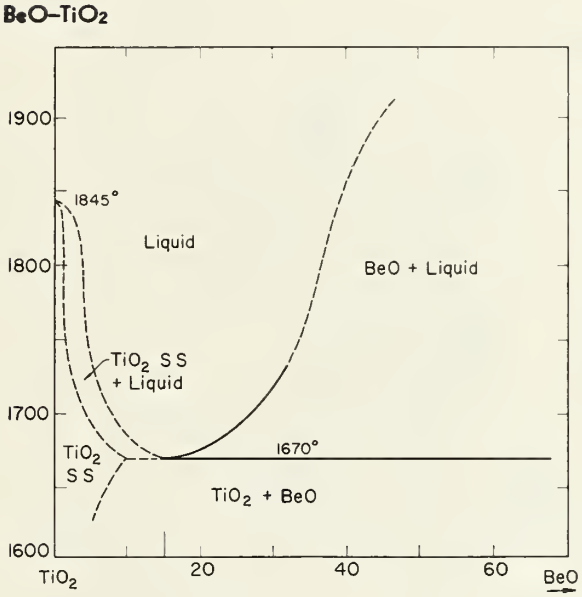

Figure 33

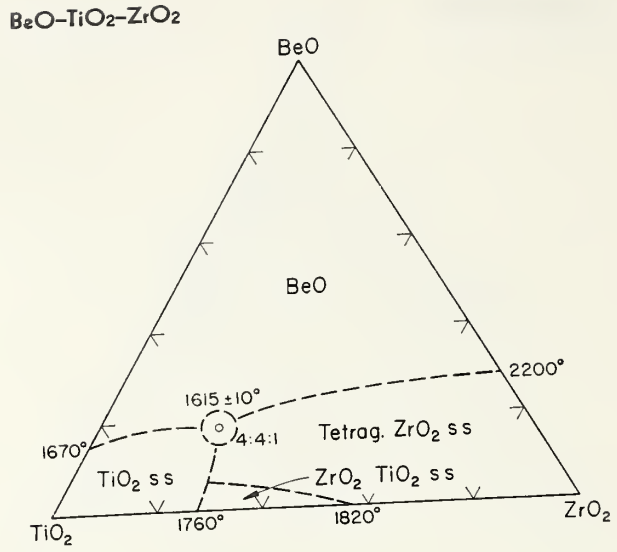

Figure 34

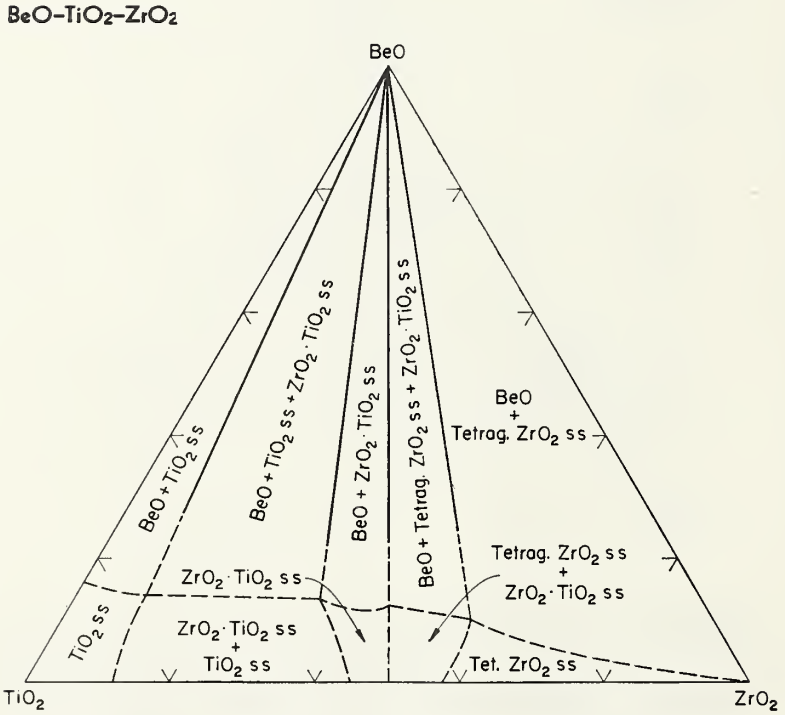

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Figure 35

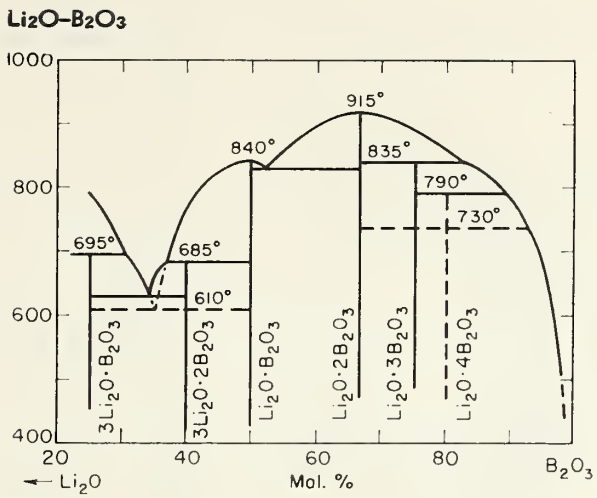

Figure 36

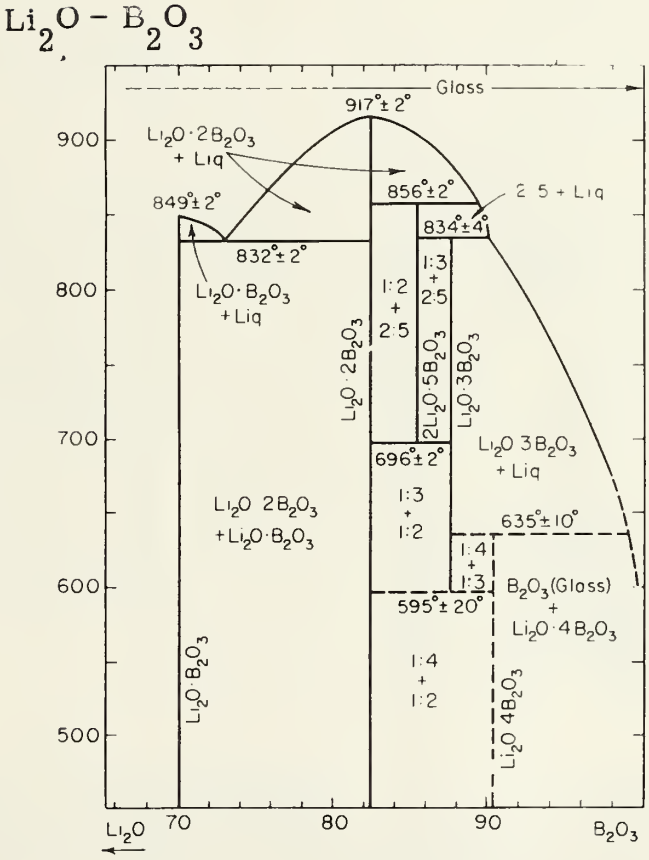

Figure 37

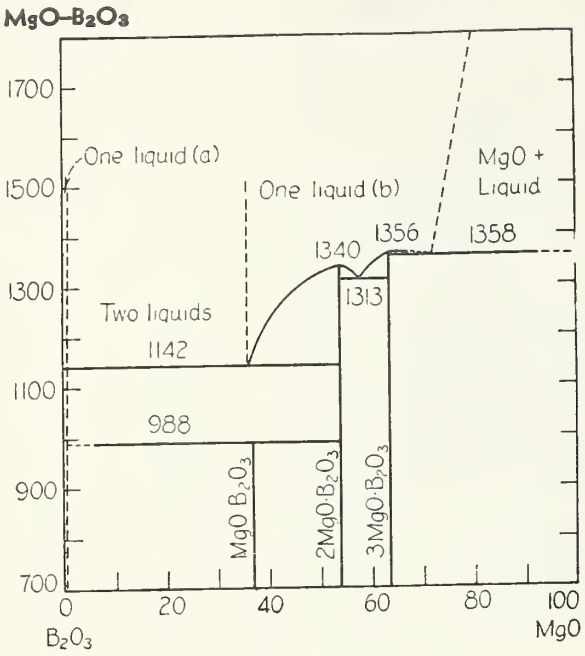

Figure 38

TiO_2 – MgO

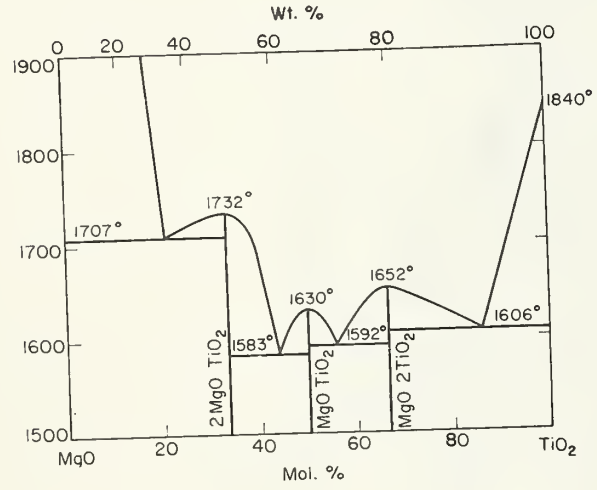

Figure 39

TiO_2 – MgO·

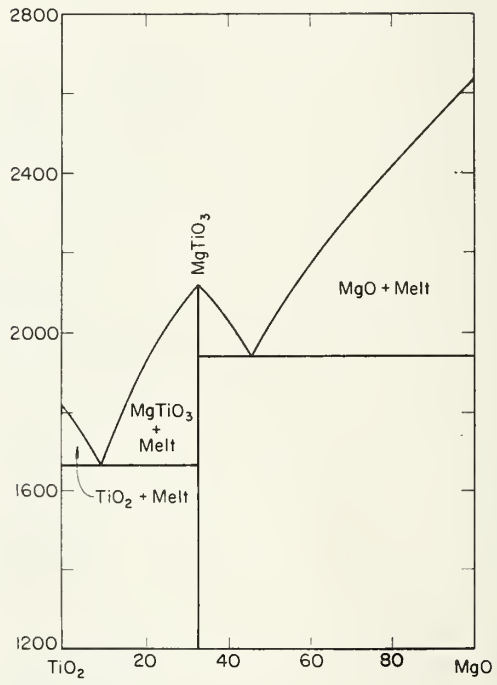

Figure 40

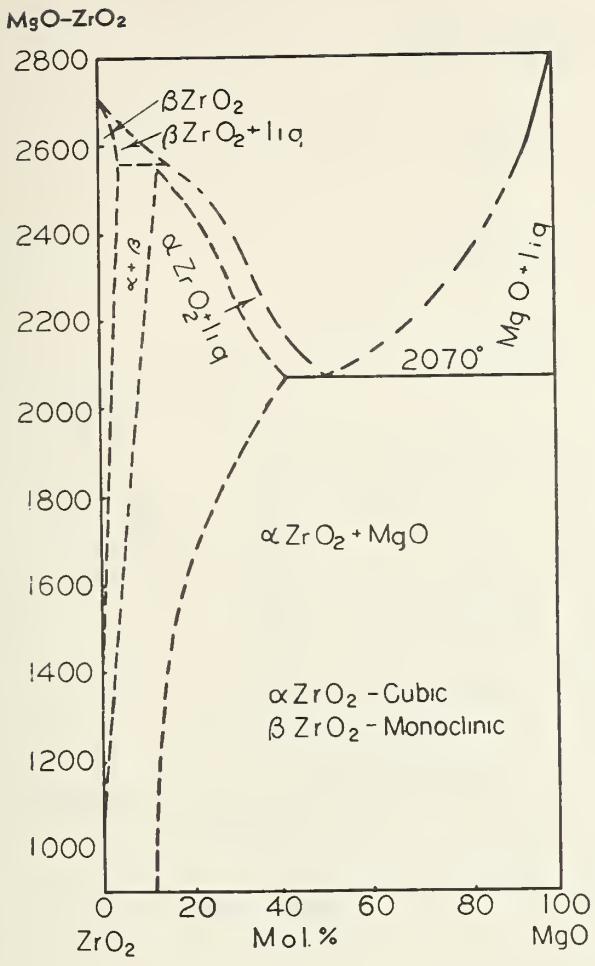

Figure 41

$MgO - ZrO_2$

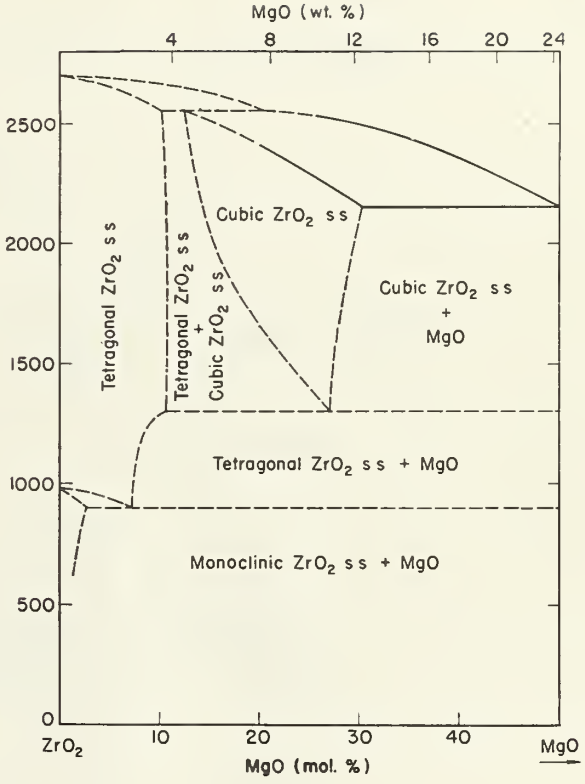

Figure 42

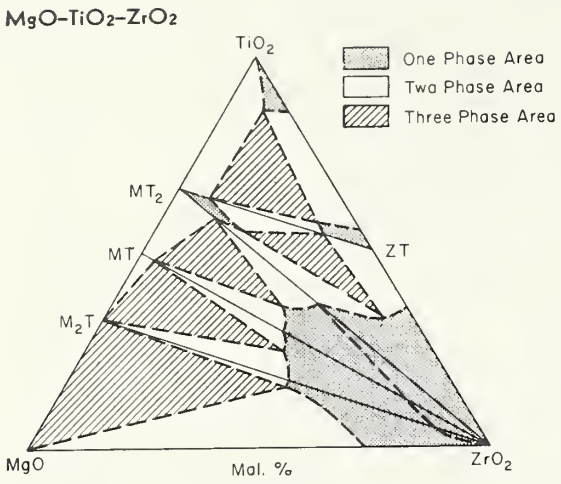

Figure 43

$ZrO_2 - TiO_2$

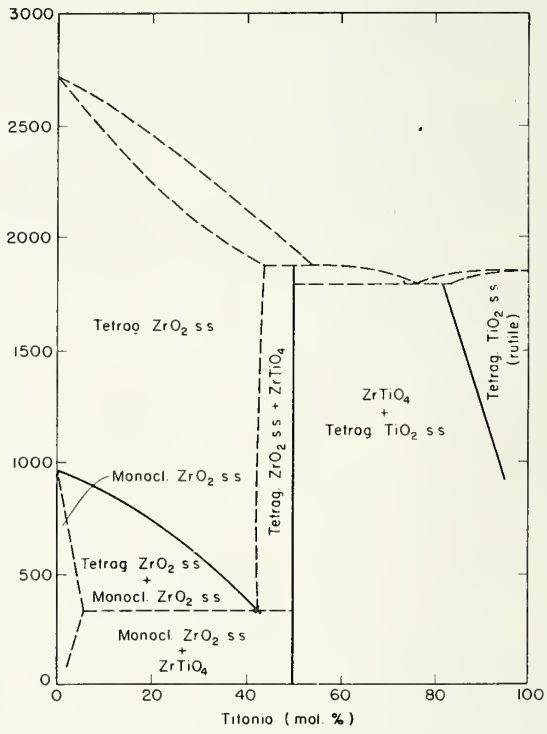

Figure 44

$ZrO_2 - TiO_2$

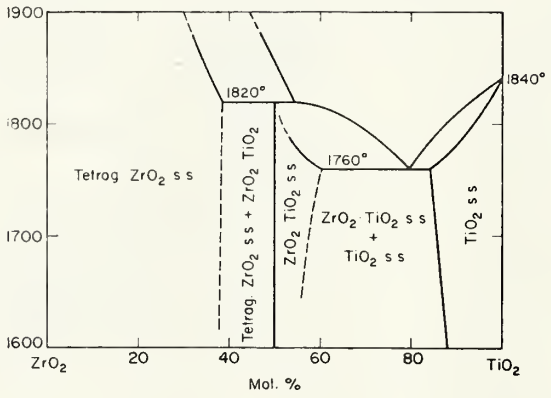

Figure 45

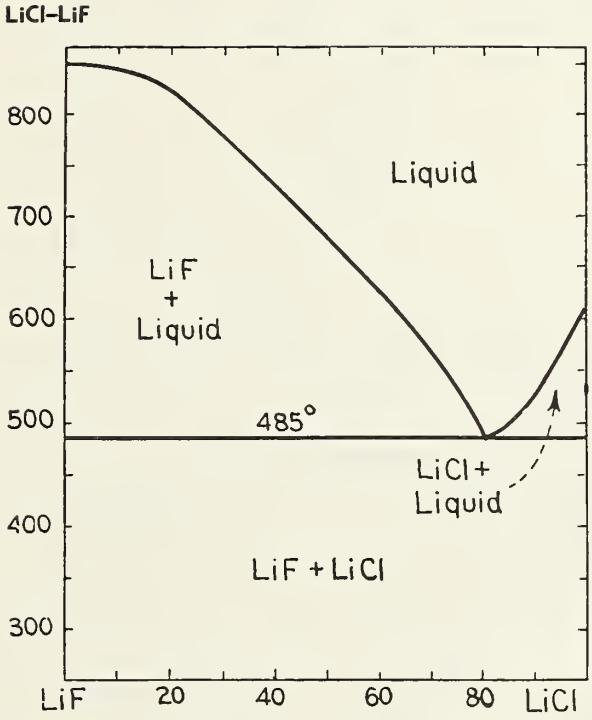

Fig. 46

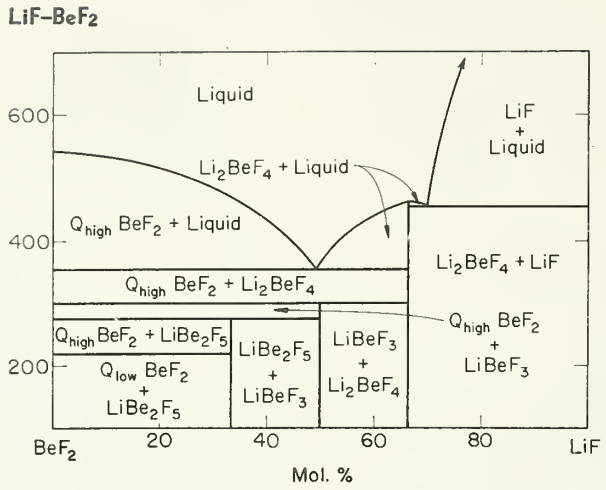

Fig. 47

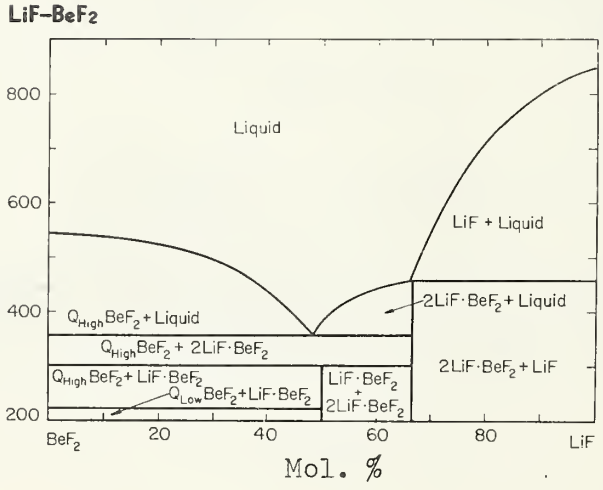

Fig. 48

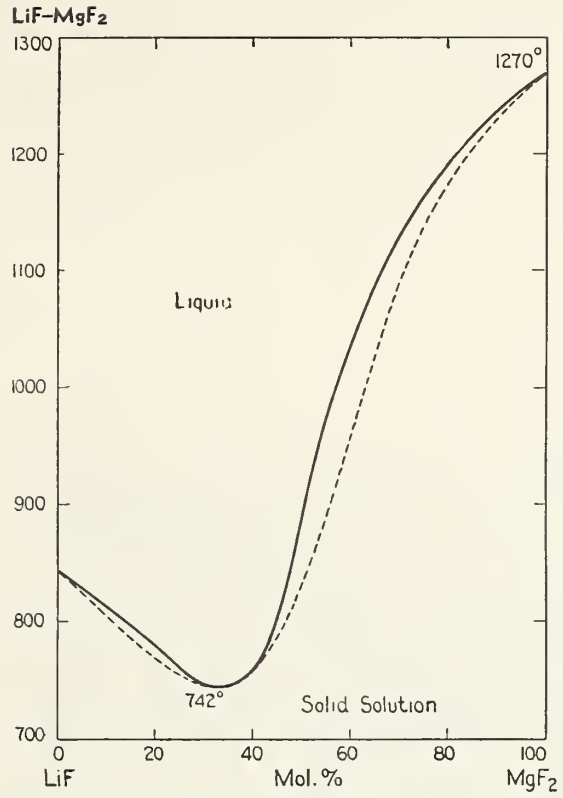

Fig. 49

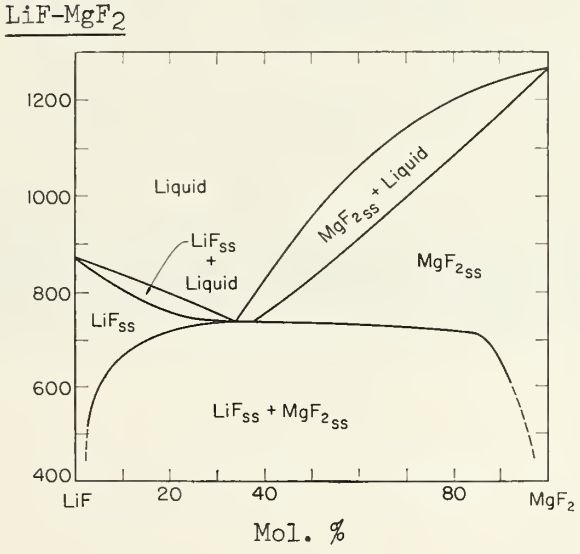

Fig. 50

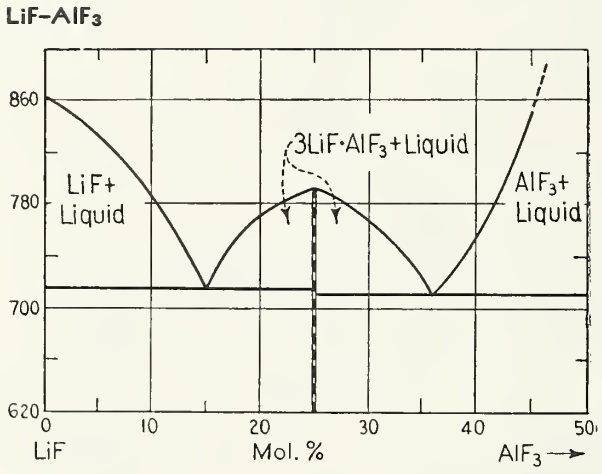

Fig. 51

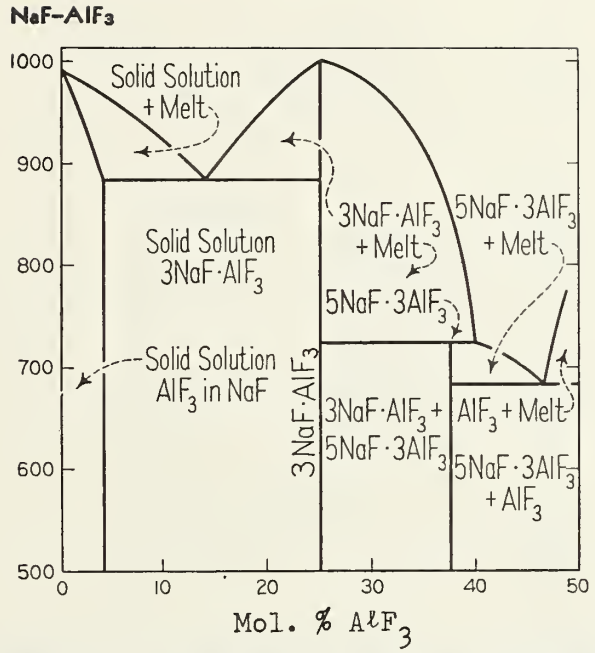

Fig. 52

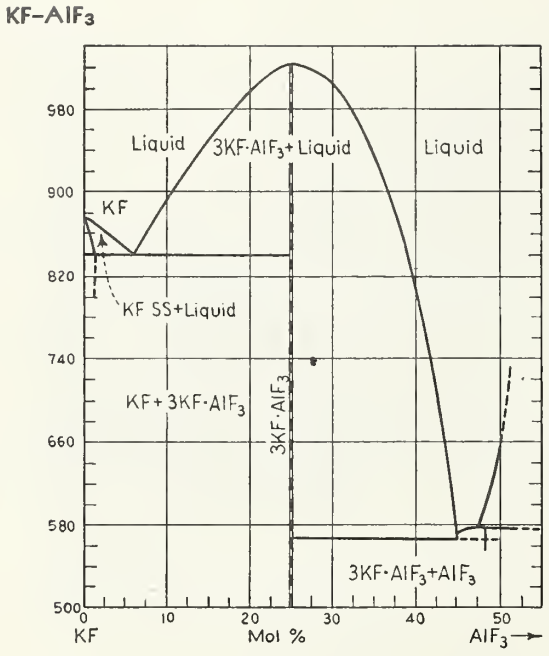

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Fig. 53

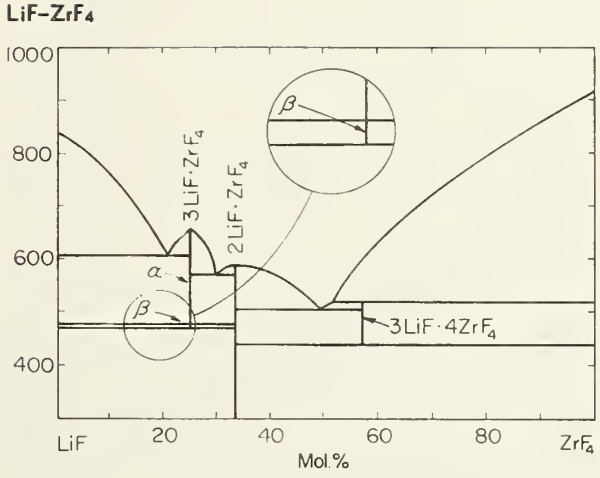

Fig. 54

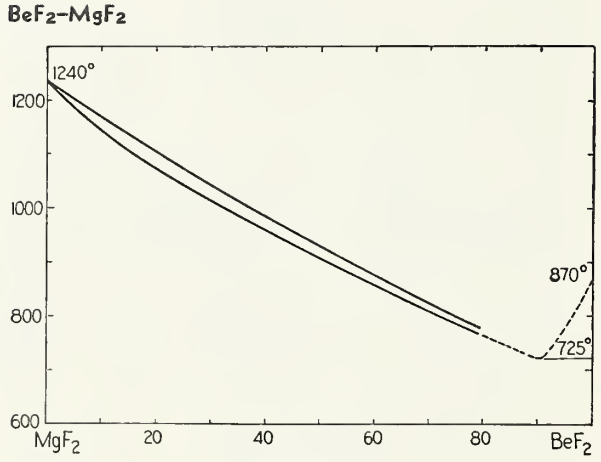

Fig. 55

MgF_2-BeF_2

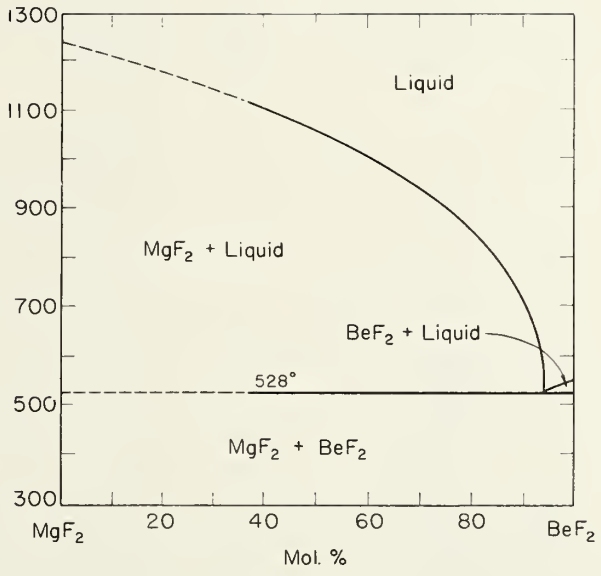

Fig. 56

For systems containing O, F, or Cl, the components are given as oxides, fluorides, and chlorides respectively. The components are listed alphabetically, and in all possible orders for a given system. Many of the diagrams are discussed in the text. This index is also convenient for determining those systems of a given component for which no phase diagrams are included in this report.

APPENDIX B

THERMODYNAMIC FUNCTIONS OF SOLIDS AND LIQUIDS

These tables are discussed in Section III 2 of this report. They form an amendment of and addition to the similar tables in Appendix B of the last report (NBS Report 6928), and the table numbers in the two reports form a continuous series.

TABLE B-21

THERMODYNAMIC FUNCTIONS FOR LITHIUM (LI)
SOLID AND LIQUID PHASES

GRAM MOLECULAR WT.=6.940 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL/DEG MOLE	CAL/DEG MOLE	CAL/DEG MOLE	CAL/MOLE	CAL/DEG MOLE	CAL/MOLE
			(SOLID)			
0.00	0.0000	0.0000	0.000	0.000	0.000	0.000
5.00	0.0004	0.0010	0.001	0.005	0.003	0.002
10.00	0.0021	0.0047	0.007	0.047	0.015	0.021
15.00	0.0052	0.0122	0.017	0.183	0.043	0.079
20.00	0.0104	0.0258	0.036	0.516	0.095	0.209
25.00	0.0183	0.0463	0.065	1.158	0.166	0.458
30.00	0.0291	0.0748	0.104	2.245	0.275	0.874
35.00	0.0434	0.1134	0.157	3.969	0.419	1.519
40.00	0.0616	0.1615	0.223	6.462	0.582	2.464
45.00	0.0838	0.2186	0.302	9.835	0.770	3.771
50.00	0.1101	0.2834	0.394	14.171	0.967	5.507
55.00	0.1405	0.3554	0.496	19.546	1.185	7.726
60.00	0.1747	0.4338	0.608	26.026	1.408	10.482
65.00	0.2127	0.5175	0.730	33.636	1.636	13.825
70.00	0.2542	0.6053	0.860	42.372	1.858	17.797
75.00	0.2991	0.6964	0.995	52.227	2.084	22.432
80.00	0.3470	0.7900	1.137	63.203	2.306	27.761
85.00	0.3978	0.8856	1.283	75.279	2.524	33.810
90.00	0.4511	0.9827	1.434	88.445	2.742	40.602
95.00	0.5070	1.0808	1.588	102.67	2.951	48.168
100.00	0.5650	1.1800	1.745	118.00	3.191	56.498
105.00	0.6250	1.2852	1.910	134.94	3.667	65.630
110.00	0.6875	1.3998	2.087	153.98	3.832	75.625
115.00	0.7521	1.5052	2.257	173.09	3.819	86.490
120.00	0.8182	1.6024	2.421	192.29	3.868	98.186
125.00	0.8855	1.6946	2.580	211.82	3.948	110.69
130.00	0.9537	1.7831	2.737	231.80	4.046	123.98
135.00	1.0226	1.8688	2.892	252.29	4.154	138.05
140.00	1.0921	1.9525	3.045	273.35	4.269	152.89
145.00	1.1621	2.0343	3.196	294.98	4.379	168.50
150.00	1.2324	2.1141	3.346	317.12	4.475	184.86
155.00	1.3030	2.1916	3.495	339.70	4.556	201.96
160.00	1.3737	2.2667	3.640	362.67	4.632	219.80
165.00	1.4446	2.3397	3.784	386.05	4.722	238.36
170.00	1.5155	2.4106	3.926	409.81	4.751	257.64
175.00	1.5864	2.4786	4.065	433.76	4.829	277.62
180.00	1.6571	2.5449	4.202	458.08	4.897	298.28
185.00	1.7277	2.6094	4.337	482.74	4.966	319.63
190.00	1.7981	2.6723	4.470	507.73	5.030	341.65
195.00	1.8684	2.7335	4.602	533.04	5.091	364.33
200.00	1.9383	2.7932	4.732	558.64	5.148	387.66
205.00	2.0080	2.8513	4.859	584.51	5.202	411.64
210.00	2.0774	2.9078	4.985	610.65	5.253	436.25
215.00	2.1465	2.9630	5.109	637.03	5.302	461.49
220.00	2.2152	3.0166	5.232	663.66	5.349	487.35
225.00	2.2836	3.0690	5.353	690.52	5.395	513.81
230.00	2.3516	3.1200	5.472	717.61	5.439	540.87
235.00	2.4192	3.1698	5.589	744.91	5.482	568.52
240.00	2.4865	3.2184	5.705	772.42	5.524	596.76
245.00	2.5533	3.2659	5.819	800.14	5.564	625.57
250.00	2.6198	3.3122	5.932	828.06	5.602	654.95
255.00	2.6858	3.3575	6.043	856.16	5.640	684.88
260.00	2.7514	3.4017	6.153	884.45	5.675	715.38
265.00	2.8167	3.4449	6.262	912.91	5.709	746.41
270.00	2.8814	3.4872	6.369	941.54	5.741	777.99
273.15	2.9220	3.5133	6.435	959.65	5.761	798.16
275.00	2.9458	3.5284	6.474	970.32	5.773	810.10
280.00	3.0098	3.5688	6.578	999.26	5.803	842.73
285.00	3.0733	3.6082	6.682	1028.3	5.832	875.88
290.00	3.1364	3.6468	6.783	1057.6	5.860	909.54
295.00	3.1990	3.6846	6.884	1086.9	5.888	943.71
298.15	3.2383	3.7080	6.946	1105.5	5.906	965.49
300.00	3.2613	3.7215	6.983	1116.5	5.916	978.38

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

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TABLE B-21(CONT.)

THERMODYNAMIC FUNCTIONS FOR LITHIUM (LI)
SOLID AND LIQUID PHASES

GRAM MOLECULAR WT.=6.940 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			(SOLID)			
300.00	3.2613	3.7215	6.983	1116.5	5.916	978.38
310.00	3.3845	3.7932	7.178	1175.9	5.971	1049.2
320.00	3.5060	3.8621	7.368	1235.9	6.024	1121.9
330.00	3.6259	3.9284	7.554	1296.4	6.076	1196.5
340.00	3.7441	3.9924	7.736	1357.4	6.130	1273.0
350.00	3.8607	4.0543	7.915	1419.0	6.188	1351.2
360.00	3.9758	4.1144	8.090	1481.2	6.255	1431.3
370.00	4.0893	4.1733	8.263	1544.1	6.330	1513.0
373.15	4.1248	4.1916	8.316	1564.1	6.355	1539.2
380.00	4.2014	4.2311	8.432	1607.8	6.411	1596.5
390.00	4.3120	4.2881	8.600	1672.4	6.497	1681.7
400.00	4.4213	4.3444	8.766	1737.8	6.586	1768.5
425.00	4.6888	4.4830	9.172	1905.3	6.820	1992.8
450.00	4.9490	4.6198	9.569	2078.9	7.071	2227.0
453.70	4.9868	4.6400	9.627	2105.2	7.108	2262.5
			(LIQUID)			
453.70	4.9868	6.2167	11.204	2820.5	7.350	2262.5
475.00	5.2740	6.2651	11.539	2975.9	7.281	2505.2
500.00	5.5967	6.3141	11.911	3157.0	7.212	2798.3
550.00	6.2023	6.3907	12.593	3514.9	7.109	3411.2
600.00	6.7609	6.4474	13.208	3868.5	7.038	4056.5
650.00	7.2787	6.4908	13.770	4219.0	6.988	4731.2
700.00	7.7611	6.5251	14.286	4567.6	6.954	5432.7
750.00	8.2122	6.5529	14.765	4914.6	6.931	6159.2
800.00	8.6359	6.5760	15.212	5260.8	6.915	6908.7
850.00	9.0352	6.5956	15.631	5606.2	6.904	7679.9
900.00	9.4126	6.6125	16.025	5951.3	6.897	8471.4
950.00	9.7706	6.6273	16.398	6296.0	6.892	9282.0
1000.00	10.111	6.6405	16.751	6640.5	6.889	10111.
1050.00	10.435	6.6523	17.087	6984.9	6.886	10957.
1100.00	10.745	6.6629	17.408	7329.1	6.884	11819.
1150.00	11.041	6.6724	17.714	7673.3	6.881	12697.
1200.00	11.325	6.6810	18.006	8017.3	6.878	13590.

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

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TABLE B-26

THERMODYNAMIC FUNCTIONS FOR LITHIUM CHLORIDE (LI CL)
SOLID AND LIQUID PHASES

GRAM MOLECULAR WT.=42.397 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			(SOLID)			
0.	0.	0.	0.	0.	0.	0.
5.00	0.0001	0.0004	0.000	0.002	0.002	0.000
10.00	0.0012	0.0038	0.005	0.038	0.015	0.012
15.00	0.0041	0.0125	0.017	0.187	0.050	0.062
20.00	0.0099	0.0311	0.041	0.623	0.136	0.199
25.00	0.0203	0.0668	0.087	1.671	0.298	0.508
30.00	0.0372	0.1255	0.163	3.765	0.554	1.117
35.00	0.0626	0.2094	0.272	7.328	0.883	2.190
40.00	0.0973	0.3180	0.415	12.721	1.284	3.893
45.00	0.1422	0.4502	0.592	20.257	1.737	6.398
50.00	0.1973	0.6025	0.800	30.125	2.214	9.867
55.00	0.2626	0.7715	1.034	42.432	2.712	14.441
60.00	0.3374	0.9546	1.292	57.278	3.227	20.247
65.00	0.4215	1.1491	1.571	74.690	3.736	27.396
70.00	0.5140	1.3517	1.866	94.619	4.231	35.980
75.00	0.6143	1.5592	2.174	116.94	4.691	46.074
80.00	0.7216	1.7686	2.490	141.49	5.126	57.730
85.00	0.8352	1.9783	2.814	168.16	5.538	70.987
90.00	0.9541	2.1870	3.141	196.83	5.926	85.872
95.00	1.0779	2.3935	3.471	227.38	6.293	102.40
100.00	1.2059	2.5972	3.803	259.72	6.637	120.59
105.00	1.3375	2.7972	4.135	293.71	6.954	140.43
110.00	1.4721	2.9929	4.465	329.22	7.250	161.93
115.00	1.6094	3.1842	4.794	366.18	7.531	185.08
120.00	1.7489	3.3708	5.120	404.50	7.792	209.87
125.00	1.8902	3.552(	5.443	444.08	8.038	236.27
130.00	2.0330	3.7296	5.763	484.85	8.268	264.29
135.00	2.1770	3.9018	6.079	526.74	8.485	293.89
140.00	2.3219	4.0691	6.391	569.68	8.687	325.07
145.00	2.4676	4.2317	6.699	613.59	8.877	357.80
150.00	2.6137	4.3895	7.003	658.43	9.055	392.06
155.00	2.7601	4.5427	7.303	704.12	9.220	427.82
160.00	2.9067	4.6913	7.598	750.61	9.373	465.08
165.00	3.0533	4.8354	7.889	797.84	9.516	503.80
170.00	3.1997	4.9750	8.175	845.76	9.650	543.96
175.00	3.3459	5.1104	8.456	894.32	9.774	585.54
180.00	3.4917	5.2416	8.733	943.49	9.892	628.51
185.00	3.6371	5.3688	9.006	993.23	10.003	672.86
190.00	3.7819	5.4922	9.274	1043.5	10.110	718.56
195.00	3.9261	5.6119	9.538	1094.3	10.212	765.59
200.00	4.0697	5.7282	9.798	1145.6	10.311	813.94
205.00	4.2125	5.8411	10.054	1197.4	10.405	863.57
210.00	4.3546	5.9508	10.305	1249.7	10.495	914.47
215.00	4.4959	6.0575	10.553	1302.4	10.581	966.61
220.00	4.6363	6.1612	10.798	1355.5	10.662	1020.0
225.00	4.7759	6.2621	11.038	1409.0	10.739	1074.6
230.00	4.9146	6.3602	11.275	1462.9	10.812	1130.4
235.00	5.0525	6.4557	11.508	1517.1	10.882	1187.3
240.00	5.1893	6.5487	11.738	1571.7	10.950	1245.4
245.00	5.3253	6.6392	11.964	1626.6	11.016	1304.7
250.00	5.4603	6.7273	12.188	1681.8	11.079	1365.1
255.00	5.5944	6.8133	12.408	1737.4	11.141	1426.6
260.00	5.7275	6.8971	12.625	1793.2	11.199	1489.2
265.00	5.8597	6.9788	12.838	1849.4	11.255	1552.8
270.00	5.9909	7.0584	13.049	1905.8	11.307	1617.5
273.15	6.0730	7.1076	13.181	1941.4	11.338	1658.8
275.00	6.1211	7.1361	13.257	1962.4	11.355	1683.3
280.00	6.2504	7.2119	13.462	2019.3	11.400	1750.1
285.00	6.3787	7.2857	13.664	2076.4	11.442	1817.9
290.00	6.5060	7.3577	13.864	2133.7	11.481	1886.7
295.00	6.6324	7.4279	14.060	2191.2	11.519	1956.6
298.15	6.7115	7.4713	14.183	2227.6	11.542	2001.0
300.00	6.7578	7.4964	14.254	2248.9	11.556	2027.3

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

REVISED REVISED

TABLE B-26(CONT.)

THERMODYNAMIC FUNCTIONS FOR LITHIUM CHLORIDE (LI CL)
SOLID AND LIQUID PHASES

GRAM MOLECULAR WT.=42.397 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL/DEG MOLE	CAL/DEG MOLE	CAL/DEG MOLE	CAL/MOLE	CAL/DEG MOLE	CAL/MOLE
			(SOLID)			
300.00	6.7578	7.4964	14.254	2248.9	11.556	2027.3
310.00	7.0058	7.6285	14.634	2364.8	11.627	2171.8
320.00	7.2500	7.7546	15.005	2481.5	11.696	2320.0
330.00	7.4905	7.8750	15.365	2598.8	11.764	2471.8
340.00	7.7273	7.9904	15.718	2716.7	11.830	2627.3
350.00	7.9605	8.1010	16.061	2835.3	11.895	2786.2
360.00	8.1902	8.2073	16.397	2954.6	11.958	2948.5
370.00	8.4165	8.3095	16.726	3074.5	12.020	3114.1
373.15	8.4871	8.3409	16.828	3112.4	12.039	3166.9
380.00	8.6394	8.4079	17.047	3195.0	12.080	3283.0
390.00	8.8590	8.5026	17.362	3316.1	12.140	3455.0
400.00	9.0755	8.5945	17.670	3437.8	12.201	3630.2
425.00	9.6031	8.8111	18.414	3744.7	12.349	4081.3
450.00	10.112	9.0115	19.124	4055.2	12.491	4550.6
475.00	10.605	9.1984	19.803	4369.2	12.632	5037.3
500.00	11.081	9.3736	20.455	4686.8	12.772	5540.5
550.00	11.990	9.6950	21.685	5332.3	13.046	6594.4
600.00	12.846	9.9856	22.832	5991.4	13.318	7707.6
650.00	13.656	10.252	23.908	6664.0	13.585	8876.4
700.00	14.425	10.500	24.925	7349.9	13.851	10097.
750.00	15.157	10.732	25.889	8049.0	14.114	11368.
800.00	15.857	10.952	26.809	8761.3	14.376	12686.
850.00	16.527	11.161	27.688	9486.6	14.637	14048.
885.00	16.980	11.302	28.282	10002.	14.819	15028.
			(LIQUID)			
885.00	16.980	16.644	33.625	14730.	15.696	15028.
900.00	17.260	16.628	33.888	14965.	15.676	15534.
950.00	18.158	16.576	34.734	15747.	15.608	17250.
1000.00	19.007	16.526	35.533	16526.	15.540	19007.
1050.00	19.812	16.477	36.289	17301.	15.472	20802.
1100.00	20.577	16.430	37.007	18073.	15.404	22635.
1150.00	21.307	16.384	37.691	18842.	15.336	24503.
1200.00	22.003	16.339	38.342	19607.	15.268	26404.
1250.00	22.669	16.295	38.964	20368.	15.200	28336.
1300.00	23.307	16.251	39.559	21127.	15.132	30299.
1350.00	23.920	16.209	40.128	21882.	15.064	32292.
1400.00	24.509	16.167	40.675	22633.	14.996	34312.
1450.00	25.075	16.125	41.200	23381.	14.928	36359.
1500.00	25.621	16.084	41.705	24126.	14.860	38432.
1550.00	26.148	16.043	42.191	24867.	14.792	40529.
1600.00	26.656	16.003	42.660	25605.	14.723	42650.
1650.00	27.148	15.963	43.112	26340.	14.655	44795.
1700.00	27.624	15.924	43.548	27071.	14.587	46961.
1750.00	28.085	15.885	43.970	27798.	14.519	49149.
1800.00	28.532	15.846	44.378	28523.	14.451	51358.
1850.00	28.966	15.807	44.773	29243.	14.383	53587.
1900.00	29.387	15.769	45.156	29961.	14.315	55835.
1950.00	29.796	15.731	45.527	30675.	14.247	58102.
2000.00	30.194	15.693	45.887	31386.	14.179	60388.
2050.00	30.581	15.655	46.236	32093.	14.111	62691.
2100.00	30.958	15.617	46.575	32797.	14.043	65011.
2150.00	31.325	15.580	46.905	33497.	13.975	67348.
2200.00	31.682	15.543	47.225	34194.	13.907	69701.
2250.00	32.031	15.506	47.537	34888.	13.839	72071.
2300.00	32.372	15.469	47.841	35578.	13.771	74455.
2350.00	32.704	15.432	48.136	36265.	13.703	76854.
2400.00	33.029	15.395	48.424	36948.	13.635	79268.
2450.00	33.346	15.359	48.704	37628.	13.567	81697.
2500.00	33.656	15.322	48.978	38305.	13.499	84139.

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

REVISED REVISED

TABLE B-41

THERMODYNAMIC FUNCTIONS FOR TITANIUM MONOXIDE (TI O)
SOLID PHASES

GRAM MOLECULAR WT.= 63.90 GRAMS 1 CAL=4.1840 ABS J
T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE

SOLID PHASE (ALPHA)

0.00	0.	0.	0.	0.	0.	0.
5.00	0.0000	0.0001	0.000	0.001	0.001	0.000
10.00	0.0004	0.0015	0.002	0.015	0.006	0.005
15.00	0.0016	0.0049	0.007	0.074	0.019	0.024
20.00	0.0038	0.0113	0.015	0.226	0.044	0.076
25.00	0.0073	0.0216	0.029	0.540	0.085	0.184
30.00	0.0126	0.0370	0.050	1.109	0.147	0.377
35.00	0.0198	0.0586	0.078	2.049	0.234	0.692
40.00	0.0294	0.0873	0.117	3.490	0.347	1.176
45.00	0.0417	0.1237	0.165	5.566	0.488	1.876
50.00	0.0570	0.1682	0.225	8.409	0.654	2.847
55.00	0.0754	0.2207	0.296	12.141	0.843	4.146
60.00	0.0971	0.2812	0.378	16.869	1.052	5.827
65.00	0.1223	0.3490	0.471	22.686	1.277	7.946
70.00	0.1508	0.4238	0.575	29.663	1.516	10.557
75.00	0.1828	0.5047	0.688	37.856	1.763	13.708
80.00	0.2181	0.5913	0.809	47.300	2.016	17.447
85.00	0.2567	0.6826	0.939	58.018	2.272	21.815
90.00	0.2984	0.7781	1.076	70.024	2.530	26.851
95.00	0.3431	0.8771	1.220	83.323	2.789	32.590
100.00	0.3906	0.9792	1.370	97.915	3.048	39.062
105.00	0.4409	1.0838	1.525	113.80	3.305	46.296
110.00	0.4938	1.1906	1.684	130.96	3.561	54.317
115.00	0.5491	1.2991	1.848	149.40	3.814	63.147
120.00	0.6067	1.4092	2.016	169.10	4.065	72.806
125.00	0.6665	1.5203	2.187	190.04	4.312	83.311
130.00	0.7283	1.6324	2.361	212.21	4.554	94.679
135.00	0.7920	1.7450	2.537	235.58	4.792	106.92
140.00	0.8575	1.8580	2.716	260.12	5.024	120.05
145.00	0.9247	1.9711	2.896	285.81	5.250	134.08
150.00	0.9934	2.0841	3.078	312.61	5.470	149.01
155.00	1.0636	2.1968	3.260	340.50	5.684	164.86
160.00	1.1351	2.3090	3.444	369.44	5.891	181.62
165.00	1.2079	2.4206	3.629	399.40	6.092	199.30
170.00	1.2818	2.5315	3.813	430.35	6.287	217.90
175.00	1.3568	2.6415	3.998	462.26	6.476	237.43
180.00	1.4327	2.7506	4.183	495.10	6.658	257.89
185.00	1.5095	2.8586	4.368	528.84	6.835	279.27
190.00	1.5872	2.9655	4.553	563.44	7.006	301.57
195.00	1.6656	3.0712	4.737	598.89	7.171	324.79
200.00	1.7447	3.1757	4.920	635.15	7.331	348.93
205.00	1.8244	3.2790	5.103	672.19	7.485	373.99
210.00	1.9046	3.3809	5.286	709.99	7.634	399.97
215.00	1.9853	3.4815	5.467	748.52	7.777	426.85
220.00	2.0665	3.5807	5.647	787.75	7.915	454.63
225.00	2.1481	3.6785	5.827	827.67	8.049	483.32
230.00	2.2300	3.7749	6.005	868.23	8.177	512.90
235.00	2.3122	3.8699	6.182	909.43	8.300	543.37
240.00	2.3947	3.9634	6.358	951.23	8.419	574.72
245.00	2.4773	4.0556	6.533	993.61	8.534	606.94
250.00	2.5602	4.1462	6.706	1036.6	8.644	640.04
255.00	2.6432	4.2355	6.879	1080.0	8.751	674.01
260.00	2.7263	4.3233	7.050	1124.1	8.853	708.83
265.00	2.8094	4.4097	7.219	1168.6	8.953	744.50
270.00	2.8927	4.4947	7.387	1213.6	9.049	781.02
273.15	2.9451	4.5476	7.493	1242.2	9.109	804.45
275.00	2.9759	4.5784	7.554	1259.1	9.143	818.37
280.00	3.0591	4.6607	7.720	1305.0	9.235	856.56
285.00	3.1423	4.7418	7.884	1351.4	9.324	895.57
290.00	3.2255	4.8215	8.047	1398.2	9.413	935.40
295.00	3.3086	4.9001	8.209	1445.5	9.499	976.04
298.15	3.3609	4.9490	8.310	1475.5	9.553	1002.1
300.00	3.3916	4.9775	8.369	1493.2	9.585	1017.5

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-41(CONT.)

THERMODYNAMIC FUNCTIONS FOR TITANIUM MONOXIDE (TI O)
SOLID PHASES

GRAM MOLECULAR WT.= 63.90 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL/DEG MOLE	CAL/DEG MOLE	CAL/DEG MOLE	CAL/MOLE	CAL/DEG MOLE	CAL/MOLE
			SOLID PHASE (ALPHA)			
300.00	3.3916	4.9775	8.369	1493.2	9.585	1017.5
310.00	3.5573	5.1288	8.686	1589.9	9.749	1102.8
320.00	3.7225	5.2756	8.998	1688.2	9.905	1191.2
330.00	3.8870	5.4181	9.305	1788.0	10.050	1282.7
340.00	4.0508	5.5564	9.607	1889.2	10.185	1377.3
350.00	4.2138	5.6904	9.904	1991.7	10.312	1474.8
360.00	4.3759	5.8205	10.196	2095.4	10.431	1575.3
370.00	4.5372	5.9466	10.484	2200.3	10.543	1678.7
373.15	4.5877	5.9856	10.573	2233.5	10.577	1711.9
380.00	4.6974	6.0690	10.766	2306.2	10.650	1785.0
390.00	4.8566	6.1878	11.044	2413.2	10.751	1894.1
400.00	5.0147	6.3031	11.318	2521.2	10.848	2005.9
425.00	5.4051	6.5771	11.982	2795.3	11.070	2297.2
450.00	5.7884	6.8324	12.621	3074.6	11.271	2604.8
475.00	6.1642	7.0709	13.235	3358.7	11.456	2928.0
500.00	6.5327	7.2944	13.827	3647.2	11.626	3266.3
550.00	7.2474	7.7025	14.950	4236.4	11.935	3986.0
600.00	7.9335	8.0670	16.000	4840.2	12.213	4760.1
650.00	8.5924	8.3959	16.988	5457.3	12.470	5585.0
700.00	9.2257	8.6956	17.921	6086.9	12.710	6458.0
750.00	9.8352	8.9709	18.806	6728.2	12.939	7376.4
800.00	10.422	9.2258	19.648	7380.7	13.159	8337.9
850.00	10.989	9.4635	20.452	8044.0	13.373	9340.6
900.00	11.536	9.6865	21.223	8717.8	13.580	10383.
950.00	12.066	9.8968	21.962	9402.0	13.784	11462.
1000.00	12.578	10.096	22.674	10096.	13.984	12578.
1050.00	13.076	10.286	23.362	10800.	14.181	13729.
1100.00	13.558	10.467	24.026	11514.	14.376	14914.
1150.00	14.027	10.642	24.669	12238.	14.569	16132.
1200.00	14.484	10.809	25.293	12971.	14.761	17381.
1250.00	14.928	10.971	25.900	13714.	14.951	18661.
1264.00	15.051	11.016	26.067	13924.	15.004	19025.
			SOLID PHASE (BETA)			
1264.00	15.051	11.665	26.716	14744.	15.642	19025.
1300.00	15.381	11.776	27.157	15309.	15.750	19995.
1350.00	15.828	11.926	27.754	16100.	15.900	21368.
1400.00	16.265	12.071	28.335	16899.	16.050	22771.
1450.00	16.691	12.210	28.901	17705.	16.200	24202.
1500.00	17.107	12.346	29.453	18519.	16.350	25660.
1550.00	17.514	12.477	29.991	19340.	16.500	27147.
1600.00	17.912	12.606	30.518	20169.	16.650	28659.
1650.00	18.302	12.730	31.032	21005.	16.800	30198.
1700.00	18.684	12.852	31.536	21849.	16.950	31762.
1750.00	19.058	12.971	32.030	22700.	17.100	33352.
1800.00	19.425	13.088	32.513	23559.	17.250	34965.
1850.00	19.785	13.203	32.988	24425.	17.400	36603.
1900.00	20.139	13.315	33.454	25299.	17.550	38264.
1950.00	20.486	13.426	33.912	26180.	17.700	39948.
2000.00	20.825	13.538	34.363	27076.	17.850	41650.

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-42

THERMODYNAMIC FUNCTIONS FOR TITANIUM SESQUIOXIDE (Ti_2O_3)
SOLID PHASES

GRAM MOLECULAR WT.=143.80 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			SOLID PHASE (ALPHA)			
0.00	0.	0.	0.	0.	0.	0.
5.00	0.0000	0.0002	0.000	0.001	0.001	0.000
10.00	0.0008	0.0029	0.004	0.029	0.012	0.008
15.00	0.0031	0.0096	0.013	0.144	0.037	0.046
20.00	0.0074	0.0220	0.029	0.440	0.085	0.148
25.00	0.0143	0.0421	0.056	1.051	0.165	0.357
30.00	0.0244	0.0720	0.096	2.160	0.286	0.733
35.00	0.0385	0.1140	0.152	3.988	0.454	1.348
40.00	0.0572	0.1696	0.227	6.782	0.672	2.283
45.00	0.0811	0.2399	0.321	10.794	0.941	3.648
50.00	0.1106	0.3255	0.436	16.274	1.259	5.532
55.00	0.1463	0.4265	0.573	23.458	1.622	8.045
60.00	0.1883	0.5428	0.731	32.567	2.028	11.295
65.00	0.2368	0.6740	0.911	43.807	2.474	15.391
70.00	0.2920	0.8195	1.111	57.362	2.954	20.438
75.00	0.3539	0.9786	1.332	73.393	3.463	26.539
80.00	0.4224	1.1505	1.573	92.038	3.998	33.794
85.00	0.4976	1.3342	1.832	113.41	4.553	42.299
90.00	0.5794	1.5289	2.108	137.60	5.126	52.142
95.00	0.6675	1.7335	2.401	164.69	5.711	63.408
100.00	0.7618	1.9473	2.709	194.73	6.308	76.177
105.00	0.8621	2.1693	3.032	227.78	6.913	90.523
110.00	0.9683	2.3988	3.367	263.87	7.523	106.51
115.00	1.0801	2.6349	3.715	303.01	8.135	124.21
120.00	1.1974	2.8768	4.074	345.22	8.747	143.68
125.00	1.3198	3.1238	4.444	390.48	9.356	164.97
130.00	1.4472	3.3752	4.822	438.77	9.960	188.13
135.00	1.5793	3.6301	5.210	490.07	10.557	213.21
140.00	1.7160	3.8880	5.604	544.33	11.145	240.24
145.00	1.8570	4.1483	6.005	601.50	11.723	269.26
150.00	2.0020	4.4103	6.412	661.54	12.292	300.30
155.00	2.1509	4.6735	6.825	724.40	12.849	333.39
160.00	2.3035	4.9375	7.241	790.01	13.394	368.56
165.00	2.4595	5.2019	7.661	858.32	13.927	405.81
170.00	2.6187	5.4662	8.085	929.25	14.446	445.18
175.00	2.7809	5.7300	8.511	1002.8	14.952	486.66
180.00	2.9460	5.9931	8.939	1078.8	15.443	530.29
185.00	3.1138	6.2549	9.369	1157.2	15.920	576.06
190.00	3.2841	6.5154	9.799	1237.9	16.382	623.98
195.00	3.4567	6.7741	10.231	1321.0	16.828	674.05
200.00	3.6314	7.0309	10.662	1406.2	17.260	726.29
205.00	3.8082	7.2855	11.094	1493.5	17.677	780.68
210.00	3.9868	7.5378	11.525	1582.9	18.079	837.22
215.00	4.1671	7.7874	11.954	1674.3	18.466	895.92
220.00	4.3489	8.0344	12.383	1767.6	18.839	956.77
225.00	4.5322	8.2785	12.811	1862.7	19.197	1019.8
230.00	4.7168	8.5196	13.236	1959.5	19.542	1084.9
235.00	4.9026	8.7577	13.660	2058.1	19.873	1152.1
240.00	5.0895	8.9926	14.082	2158.2	20.193	1221.5
242.00	5.1645	9.0856	14.250	2198.7	20.318	1249.8
242.00	5.1645	9.1004	14.265	2202.3	20.318	1249.8
245.00	5.2773	9.2392	14.517	2263.6	20.501	1292.9
250.00	5.4668	9.4674	14.934	2366.9	20.799	1366.7
255.00	5.6565	9.6925	15.349	2471.6	21.091	1442.4
260.00	5.8468	9.9144	15.761	2577.7	21.368	1520.2
265.00	6.0378	10.133	16.171	2685.2	21.636	1600.0
270.00	6.2292	10.348	16.578	2794.1	21.897	1681.9
273.15	6.3500	10.483	16.833	2863.3	22.058	1734.5
275.00	6.4210	10.561	16.982	2904.2	22.151	1765.8
280.00	6.6132	10.770	17.383	3015.6	22.394	1851.7
285.00	6.8056	10.976	17.782	3128.1	22.635	1939.6
290.00	6.9983	11.179	18.177	3241.9	22.877	2029.5
295.00	7.1911	11.379	18.571	3356.9	23.124	2121.4
298.15	7.3126	11.504	18.817	3430.0	23.282	2180.3
300.00	7.3840	11.577	18.961	3473.2	23.376	2215.2

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-42(CONT.)

THERMODYNAMIC FUNCTIONS FOR TITANIUM SESQUIOXIDE (Ti_2O_3)
SOLID PHASES

GRAM MOLECULAR WT.=143.80 GRAMS 1 CAL=4.1840 ABS J
T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			SOLID PHASE (ALPHA)			
300.00	7.3840	11.577	18.961	3473.2	23.376	2215.2
310.00	7.7700	11.966	19.736	3709.5	23.898	2408.7
320.00	8.1560	12.347	20.503	3951.2	24.433	2609.9
330.00	8.5417	12.722	21.263	4198.2	24.971	2818.7
340.00	8.9269	13.090	22.017	4450.6	25.507	3035.2
350.00	9.3116	13.452	22.764	4708.3	26.042	3259.1
360.00	9.6956	13.810	23.505	4971.4	26.577	3490.4
370.00	10.079	14.162	24.241	5239.9	27.112	3729.1
373.15	10.199	14.272	24.471	5325.5	27.281	3805.9
380.00	10.461	14.510	24.971	5513.7	27.648	3975.2
390.00	10.842	14.853	25.696	5792.8	28.183	4228.5
400.00	11.223	15.193	26.416	6077.3	28.718	4489.1
425.00	12.169	16.028	28.197	6812.0	30.056	5171.8
450.00	13.108	16.845	29.953	7580.1	31.394	5898.8
473.00	13.966	17.582	31.548	8316.3	32.624	6606.0
			SOLID PHASE (BETA)			
473.00	13.966	18.036	32.002	8531.3	30.736	6606.0
475.00	14.034	18.234	32.268	8661.0	30.777	6666.3
500.00	14.989	18.866	33.855	9433.0	31.250	7494.5
550.00	16.844	20.025	36.869	11014.	32.023	9264.0
600.00	18.631	21.052	39.683	12631.	32.627	11179.
650.00	20.352	21.962	42.314	14275.	33.111	13229.
700.00	22.010	22.773	44.783	15941.	33.508	15407.
750.00	23.606	23.500	47.106	17625.	33.842	17704.
800.00	25.145	24.155	49.300	19324.	34.126	20116.
850.00	26.627	24.749	51.376	21037.	34.373	22633.
900.00	28.057	25.290	53.347	22761.	34.591	25251.
950.00	29.439	25.784	55.223	24495.	34.785	27967.
1000.00	30.772	26.239	57.011	26239.	34.960	30772.
1050.00	32.063	26.658	58.721	27991.	35.120	33666.
1100.00	33.312	27.046	60.358	29751.	35.267	36643.
1150.00	34.522	27.407	61.929	31518.	35.404	39700.
1200.00	35.696	27.742	63.438	33291.	35.532	42835.
1250.00	36.834	28.057	64.891	35071.	35.652	46043.
1300.00	37.941	28.351	66.292	36856.	35.766	49324.
1350.00	39.017	28.627	67.644	38647.	35.875	52672.
1400.00	40.062	28.888	68.950	40444.	35.980	56086.
1450.00	41.081	29.134	70.215	42245.	36.080	59567.
1500.00	42.072	29.368	71.440	44052.	36.177	63108.
1550.00	43.038	29.589	72.627	45863.	36.270	66709.
1600.00	43.981	29.799	73.780	47679.	36.362	60369.
1650.00	44.902	29.999	74.901	49499.	36.450	74088.
1700.00	45.800	30.190	75.990	51324.	36.537	77859.
1750.00	46.677	30.373	77.050	53153.	36.622	81684.
1800.00	47.535	30.548	78.083	54986.	36.705	85563.
1850.00	48.375	30.715	79.090	56823.	36.787	89494.
1900.00	49.196	30.876	80.072	58665.	36.867	93472.
1950.00	50.000	31.031	81.031	60510.	36.947	97500.
2000.00	50.790	31.179	81.969	62358.	37.947	101580.

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-43

THERMODYNAMIC FUNCTIONS FOR TITANIUM TRITAPENTOXIDE (Ti_3O_5)
SOLID PHASES

GRAM MOLECULAR WT.=223.70 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			SOLID PHASE (ALPHA)			
0.00	0.	0.	0.	0.	0.	0.
5.00	0.0000	0.0004	0.001	0.002	0.002	0.000
10.00	0.0016	0.0058	0.007	0.058	0.024	0.016
15.00	0.0063	0.0194	0.026	0.292	0.076	0.094
20.00	0.0150	0.0445	0.059	0.890	0.173	0.299
25.00	0.0289	0.0851	0.114	2.128	0.334	0.723
30.00	0.0494	0.1457	0.195	4.372	0.577	1.483
35.00	0.0779	0.2302	0.308	8.059	0.913	2.727
40.00	0.1156	0.3415	0.457	13.661	1.343	4.624
45.00	0.1636	0.4810	0.645	21.643	1.864	7.361
50.00	0.2227	0.6488	0.871	32.437	2.466	11.135
55.00	0.2935	0.8441	1.138	46.426	3.140	16.141
60.00	0.3762	1.0657	1.442	63.944	3.877	22.574
65.00	0.4711	1.3120	1.783	85.281	4.667	30.621
70.00	0.5780	1.5812	2.159	110.69	5.502	40.463
75.00	0.6969	1.8715	2.568	140.36	6.373	52.269
80.00	0.8275	2.1808	3.008	174.46	7.272	66.198
85.00	0.9694	2.5072	3.477	213.11	8.190	82.399
90.00	1.1223	2.8487	3.971	256.39	9.122	101.01
95.00	1.2858	3.2036	4.489	304.35	10.063	122.15
100.00	1.4594	3.5702	5.030	357.02	11.009	145.94
105.00	1.6427	3.9470	5.590	414.44	11.958	172.48
110.00	1.8351	4.3327	6.168	476.60	12.906	201.87
115.00	2.0364	4.7261	6.763	543.50	13.852	234.18
120.00	2.2460	5.1259	7.372	615.11	14.789	269.51
125.00	2.4634	5.5310	7.994	691.38	15.716	307.93
130.00	2.6883	5.9404	8.629	772.25	16.629	349.48
135.00	2.9202	6.3529	9.273	857.64	17.525	394.23
140.00	3.1587	6.7676	9.926	947.46	18.401	442.22
145.00	3.4035	7.1835	10.587	1041.6	19.257	493.50
150.00	3.6540	7.6000	11.254	1140.0	20.094	548.10
155.00	3.9100	8.0162	11.926	1242.5	20.910	606.05
160.00	4.1711	8.4317	12.603	1349.1	21.707	667.37
165.00	4.4369	8.8458	13.283	1459.5	22.483	732.09
170.00	4.7071	9.2580	13.965	1573.9	23.240	800.20
175.00	4.9814	9.6681	14.649	1691.9	23.977	871.74
180.00	5.2595	10.076	15.335	1813.6	24.693	946.70
185.00	5.5410	10.480	16.021	1938.8	25.387	1025.1
190.00	5.8259	10.881	16.707	2067.4	26.061	1106.9
195.00	6.1137	11.279	17.393	2199.4	26.713	1192.2
200.00	6.4042	11.673	18.077	2334.5	27.346	1280.8
205.00	6.6972	12.062	18.760	2472.8	27.958	1372.9
210.00	6.9925	12.448	19.441	2614.1	28.552	1468.4
215.00	7.2899	12.829	20.119	2758.3	29.127	1567.3
220.00	7.5892	13.206	20.795	2905.3	29.685	1669.6
225.00	7.8901	13.578	21.468	3055.1	30.226	1775.3
230.00	8.1926	13.946	22.139	3207.6	30.751	1884.3
235.00	8.4964	14.309	22.805	3362.6	31.261	1996.7
240.00	8.8014	14.667	23.469	3520.2	31.758	2112.3
245.00	9.1075	15.021	24.129	3680.2	32.243	2231.3
250.00	9.4145	15.370	24.785	3842.6	32.716	2353.6
255.00	9.7223	15.715	25.437	4007.3	33.179	2479.2
260.00	10.031	16.055	26.086	4174.3	33.634	2608.0
265.00	10.340	16.391	26.731	4343.6	34.082	2740.0
270.00	10.649	16.723	27.372	4515.2	34.525	2875.3
273.15	10.844	16.930	27.774	4624.3	34.803	2962.1
275.00	10.959	17.050	28.010	4688.9	34.965	3013.7
280.00	11.269	17.374	28.644	4864.8	35.405	3155.4
285.00	11.580	17.694	29.274	5042.9	35.846	3300.2
290.00	11.890	18.011	29.901	5223.3	36.291	3448.1
295.00	12.201	18.325	30.526	5405.9	36.741	3599.2
298.15	12.396	18.521	30.917	5522.0	37.028	3696.0
300.00	12.511	18.636	31.147	5590.7	37.197	3753.4

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-43(CONT.)

THERMODYNAMIC FUNCTIONS FOR TITANIUM TRITAPENTOXIDE (Ti_3O_5)
SOLID PHASES

GRAM MOLECULAR WT.=223.70 GRAMS 1 CAL=4.1840 ABS J
T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			SOLID PHASE (ALPHA)			
300.00	12.511	18.636	31.147	5590.7	37.197	3753.4
310.00	13.132	19.249	32.382	5967.3	38.122	4071.0
320.00	13.753	19.854	33.607	6353.2	39.058	4401.0
330.00	14.373	20.450	34.823	6748.5	40.002	4743.1
340.00	14.992	21.039	36.031	7153.3	40.963	5097.4
350.00	15.611	21.622	37.233	7567.8	41.951	5463.7
360.00	16.228	22.201	38.429	7992.4	42.974	5842.0
370.00	16.844	22.777	39.621	8427.4	44.034	6232.3
373.15	17.038	22.958	39.996	8566.7	44.376	6357.7
380.00	17.459	23.351	40.810	8873.2	45.129	6634.4
390.00	18.073	23.923	41.996	9330.1	46.262	7048.5
400.00	18.686	24.497	43.182	9798.6	47.447	7474.4
425.00	20.214	25.941	46.155	11025.	50.765	8591.1
450.00	21.740	27.433	49.173	12343.	54.924	97829.
			SOLID PHASE (BETA)			
450.00	21.740	32.938	54.680	14822.	45.200	97829.
475.00	23.541	33.588	57.129	15954.	45.400	11182.
500.00	25.279	34.184	59.463	17092.	45.600	12639.
550.00	28.588	35.240	63.828	19382.	46.000	15723.
600.00	31.694	36.153	67.848	21692.	46.400	19017.
650.00	34.620	36.957	71.577	24022.	46.800	22503.
700.00	37.386	37.674	75.060	26372.	47.200	26170.
750.00	40.008	38.323	78.330	28742.	47.600	30006.
800.00	42.500	38.915	81.415	31132.	48.000	34000.
850.00	44.876	39.461	84.337	33542.	48.400	38145.
900.00	47.146	39.969	87.115	35972.	48.800	42431.
950.00	49.320	40.444	89.764	38422.	49.200	46854.
1000.00	51.406	40.892	92.298	40892.	49.600	51406.
1050.00	53.411	41.316	94.728	43382.	50.000	56082.
1100.00	55.343	41.720	97.063	45892.	50.400	60877.
1150.00	57.206	42.106	99.312	48422.	50.800	65787.
1200.00	59.006	42.477	101.48	50972.	51.200	70807.
1250.00	60.747	42.834	103.58	53542.	51.600	75934.
1300.00	62.434	43.178	105.61	56132.	52.000	81164.
1350.00	64.070	43.513	107.58	58742.	52.400	86494.
1400.00	65.658	43.837	109.50	61372.	52.800	91921.
1450.00	67.202	44.153	111.35	64022.	53.200	97443.
1500.00	68.704	44.461	113.16	66692.	53.600	103060.
1550.00	70.167	44.763	114.93	69382.	54.000	108760.
1600.00	71.593	45.057	116.65	72092.	54.400	114550.

H_0^0 AND S_0^0 APPLY TO THE FEFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-44

THERMODYNAMIC FUNCTIONS FOR TITANIUM DIOXIDE (RUTILE) (TiO_2)
SOLID PHASE

GRAM MOLECULAR WT.= 79.90 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			(SOLID)			
0.00	0.0000	0.0000	0.000	0.000	0.000	0.000
5.00	0.0000	0.0000	0.000	0.000	0.000	0.000
10.00	0.0002	0.0009	0.001	0.009	0.004	0.002
15.00	0.0013	0.0057	0.007	0.086	0.034	0.019
20.00	0.0064	0.0224	0.027	0.448	0.124	0.096
25.00	0.0131	0.0549	0.068	1.372	0.253	0.326
30.00	0.0270	0.1024	0.129	3.072	0.434	0.809
35.00	0.0473	0.1649	0.212	5.772	0.651	1.654
40.00	0.0741	0.2401	0.314	9.602	0.885	2.963
45.00	0.1072	0.3255	0.433	14.646	1.136	4.823
50.00	0.1463	0.4196	0.566	20.981	1.400	7.314
55.00	0.1910	0.5212	0.712	28.666	1.676	10.504
60.00	0.2409	0.6292	0.870	37.752	1.960	14.455
65.00	0.2957	0.7427	1.039	48.278	2.251	19.223
70.00	0.3551	0.8611	1.216	60.276	2.549	24.856
75.00	0.4187	0.9837	1.402	73.773	2.851	31.399
80.00	0.4862	1.1099	1.596	88.794	3.158	38.892
85.00	0.5573	1.2396	1.797	105.36	3.471	47.371
90.00	0.6319	1.3723	2.004	123.51	3.788	56.871
95.00	0.7097	1.5079	2.218	143.25	4.109	67.424
100.00	0.7906	1.6460	2.437	164.60	4.432	79.057
105.00	0.8743	1.7864	2.661	187.58	4.757	91.798
110.00	0.9607	1.9289	2.890	212.18	5.083	105.67
115.00	1.0496	2.0731	3.123	238.40	5.407	120.70
120.00	1.1409	2.2187	3.360	266.24	5.729	136.90
125.00	1.2344	2.3655	3.600	295.69	6.048	154.30
130.00	1.3301	2.5132	3.843	326.72	6.363	172.91
135.00	1.4277	2.6616	4.089	359.32	6.673	192.74
140.00	1.5272	2.8103	4.338	393.45	6.978	213.81
145.00	1.6284	2.9592	4.588	429.08	7.276	236.12
150.00	1.7312	3.1079	4.839	466.19	7.566	259.68
155.00	1.8356	3.2563	5.092	504.73	7.850	284.51
160.00	1.9413	3.4042	5.346	544.67	8.125	310.60
165.00	2.0483	3.5513	5.600	585.97	8.392	337.97
170.00	2.1565	3.6975	5.854	628.58	8.651	366.60
175.00	2.2658	3.8427	6.108	672.47	8.903	396.51
180.00	2.3760	3.9866	6.363	717.59	9.146	427.69
185.00	2.4872	4.1293	6.617	763.92	9.382	460.13
190.00	2.5992	4.2705	6.870	811.40	9.610	493.85
195.00	2.7119	4.4103	7.122	860.01	9.832	528.83
200.00	2.8253	4.5485	7.374	909.71	10.047	565.07
205.00	2.9393	4.6852	7.625	960.47	10.256	602.57
210.00	3.0539	4.8203	7.874	1012.3	10.458	641.31
215.00	3.1689	4.9537	8.122	1065.0	10.655	681.31
220.00	3.2843	5.0854	8.370	1118.8	10.845	722.54
225.00	3.4000	5.2155	8.615	1173.5	11.030	765.00
230.00	3.5160	5.3439	8.860	1229.1	11.210	808.69
235.00	3.6323	5.4705	9.103	1285.6	11.384	853.60
240.00	3.7488	5.5955	9.344	1342.9	11.553	899.72
245.00	3.8655	5.7188	9.584	1401.1	11.717	947.04
250.00	3.9822	5.8403	9.823	1460.1	11.876	995.56
255.00	4.0991	5.9602	10.059	1519.8	12.029	1045.3
260.00	4.2159	6.0783	10.294	1580.4	12.177	1096.1
265.00	4.3328	6.1947	10.528	1641.6	12.320	1148.2
270.00	4.4497	6.3095	10.759	1703.6	12.461	1201.4
273.15	4.5233	6.3809	10.904	1742.9	12.548	1235.5
275.00	4.5665	6.4226	10.989	1766.2	12.599	1255.8
280.00	4.6832	6.5341	11.217	1829.5	12.736	1311.3
285.00	4.7999	6.6441	11.444	1893.6	12.873	1368.0
290.00	4.9164	6.7527	11.669	1958.3	13.010	1425.7
295.00	5.0327	6.8599	11.893	2023.7	13.146	1484.6
298.15	5.1059	6.9268	12.033	2065.2	13.232	1522.3
300.00	5.1489	6.9658	12.115	2089.7	13.282	1544.7

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-44(CONT.)

THERMODYNAMIC FUNCTIONS FOR TITANIUM DIOXIDE (RUTILE) (TiO_2)
SOLID PHASE

GRAM MOLECULAR WT.= 79.90 GRAMS 1 CAL=4.1840 ABS J
T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL/DEG MOLE	CAL/DEG MOLE	CAL/DEG MOLE	CAL/MOLE	CAL/DEG MOLE	CAL/MOLE
			(SOLID)			
300.00	5.1489	6.9656	12.115	2089.7	13.282	1544.7
310.00	5.3807	7.1739	12.555	2223.9	13.551	1668.0
320.00	5.6117	7.3773	12.989	2360.7	13.814	1795.7
330.00	5.8418	7.5762	13.418	2500.1	14.066	1927.8
340.00	6.0708	7.7706	13.841	2642.0	14.301	2064.1
350.00	6.2988	7.9603	14.259	2786.1	14.517	2204.6
360.00	6.5257	8.1452	14.671	2932.3	14.714	2349.2
370.00	6.7513	8.3252	15.077	3080.3	14.896	2498.0
373.15	6.8221	8.3809	15.203	3127.4	14.950	2545.7
380.00	6.9757	8.5004	15.476	3230.2	15.064	2650.8
390.00	7.1987	8.6707	15.869	3381.6	15.219	2807.5
400.00	7.4203	8.8362	16.257	3534.5	15.363	2968.1
425.00	7.9679	9.2298	17.198	3922.7	15.681	3386.4
450.00	8.5060	9.5958	18.102	4318.1	15.948	3827.7
475.00	9.0340	9.9363	18.970	4719.7	16.175	4291.2
500.00	9.5519	10.253	19.805	5126.6	16.370	4775.9
550.00	10.556	10.824	21.381	5953.4	16.686	5806.0
600.00	11.520	11.323	22.843	6794.0	16.930	6912.1
650.00	12.444	11.762	24.206	7645.5	17.122	8088.7
700.00	13.330	12.151	25.481	8505.6	17.278	9331.3
750.00	14.181	12.497	26.678	9372.8	17.407	10636.
800.00	14.997	12.807	27.805	10246.	17.514	11998.
850.00	15.782	13.087	28.869	11124.	17.606	13415.
900.00	16.538	13.340	29.878	12006.	17.685	14884.
950.00	17.265	13.571	30.836	12892.	17.754	16402.
1000.00	17.967	13.782	31.748	13782.	17.815	17967.
1050.00	18.644	13.975	32.619	14674.	17.869	19576.
1100.00	19.298	14.153	33.451	15568.	17.918	21228.
1150.00	19.931	14.318	34.249	16465.	17.963	22921.
1200.00	20.544	14.471	35.014	17365.	18.004	24652.
1250.00	21.137	14.613	35.750	18266.	18.042	26422.
1300.00	21.713	14.745	36.458	19169.	18.077	28227.
1350.00	22.272	14.869	37.141	20073.	18.109	30067.
1400.00	22.815	14.985	37.800	20980.	18.140	31941.
1450.00	23.342	15.095	38.437	21887.	18.169	33847.
1500.00	23.856	15.198	39.054	22797.	18.197	35784.
1550.00	24.356	15.295	39.651	23707.	18.223	37752.
1600.00	24.843	15.387	40.230	24619.	18.248	39749.
1650.00	25.318	15.474	40.792	25532.	18.272	41774.
1700.00	25.781	15.556	41.337	26446.	18.295	43828.
1750.00	26.233	15.635	41.868	27361.	18.318	45908.

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-45

THERMODYNAMIC FUNCTIONS FOR TITANIUM DIOXIDE (ANATASE) (TiO_2)
SOLID PHASE

GRAM MOLECULAR WT.= 79.90 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			(SOLID)			
0.00	0.	0.	0.	0.	0.	0.
5.00	0.0000	0.0002	0.000	0.001	0.001	0.000
10.00	0.0009	0.0030	0.004	0.030	0.013	0.009
15.00	0.0033	0.0103	0.014	0.154	0.040	0.049
20.00	0.0078	0.0234	0.031	0.468	0.091	0.157
30.00	0.0260	0.0762	0.102	2.285	0.299	0.778
35.00	0.0408	0.1196	0.160	4.185	0.468	1.427
40.00	0.0603	0.1760	0.236	7.040	0.681	2.411
45.00	0.0849	0.2457	0.331	11.056	0.932	3.820
50.00	0.1149	0.3282	0.443	16.412	1.215	5.747
55.00	0.1506	0.4227	0.573	23.249	1.523	8.281
60.00	0.1918	0.5279	0.720	31.672	1.848	11.506
65.00	0.2385	0.6423	0.881	41.748	2.183	15.502
70.00	0.2905	0.7645	1.055	53.514	2.524	20.336
75.00	0.3476	0.8932	1.241	66.987	2.866	26.071
80.00	0.4095	1.0271	1.437	82.170	3.208	32.761
85.00	0.4759	1.1655	1.641	99.064	3.550	40.452
90.00	0.5465	1.3075	1.854	117.67	3.893	49.188
95.00	0.6211	1.4526	2.074	138.00	4.237	59.004
100.00	0.6994	1.6004	2.300	160.04	4.578	69.935
105.00	0.7811	1.7502	2.531	183.77	4.917	82.010
110.00	0.8660	1.9017	2.768	209.19	5.248	95.256
115.00	0.9539	2.0543	3.008	236.24	5.572	109.69
120.00	1.0445	2.2075	3.252	264.89	5.887	125.34
125.00	1.1377	2.3608	3.499	295.10	6.192	142.22
130.00	1.2333	2.5139	3.747	326.80	6.490	160.33
135.00	1.3311	2.666(	3.998	359.99	6.781	179.69
140.00	1.4308	2.8186	4.249	394.61	7.066	200.31
145.00	1.5323	2.9699	4.502	430.64	7.345	222.19
150.00	1.6356	3.1203	4.756	468.05	7.619	245.33
155.00	1.7403	3.2698	5.010	506.82	7.888	269.75
160.00	1.8465	3.4182	5.265	546.92	8.150	295.44
165.00	1.9539	3.5655	5.519	588.31	8.406	322.40
170.00	2.0625	3.7116	5.774	630.97	8.655	350.63
175.00	2.1722	3.8563	6.029	674.85	8.898	380.14
180.00	2.2829	3.9996	6.283	719.93	9.133	410.91
185.00	2.3944	4.1415	6.536	766.17	9.362	442.96
190.00	2.5067	4.2818	6.789	813.54	9.585	476.27
195.00	2.6197	4.4206	7.040	862.01	9.800	510.84
200.00	2.7334	4.5577	7.291	911.54	10.010	546.67
205.00	2.8476	4.6931	7.541	962.09	10.213	583.75
210.00	2.9623	4.8269	7.789	1013.7	10.409	622.08
215.00	3.0774	4.9590	8.036	1066.2	10.600	661.64
220.00	3.1929	5.0893	8.282	1119.6	10.786	702.44
225.00	3.3087	5.2179	8.527	1174.0	10.966	744.46
230.00	3.4248	5.3448	8.770	1229.3	11.141	787.70
235.00	3.5411	5.4699	9.011	1285.4	11.312	832.16
240.00	3.6575	5.5934	9.251	1342.4	11.478	877.81
245.00	3.7741	5.7151	9.489	1400.2	11.640	924.66
250.00	3.8908	5.8352	9.726	1458.8	11.798	972.70
255.00	4.0075	5.9536	9.961	1518.2	11.953	1021.9
260.00	4.1243	6.0705	10.195	1578.3	12.106	1072.3
265.00	4.2410	6.1858	10.427	1639.2	12.256	1123.9
270.00	4.3577	6.2996	10.657	1700.9	12.405	1176.6
273.15	4.4312	6.3705	10.802	1740.1	12.498	1210.4
275.00	4.4743	6.4119	10.886	1763.3	12.553	1230.4
280.00	4.5908	6.5229	11.114	1826.4	12.700	1285.4
285.00	4.7073	6.6325	11.340	1890.3	12.847	1341.6
290.00	4.8236	6.7409	11.564	1954.9	12.994	1398.8
295.00	4.9397	6.8482	11.788	2020.2	13.142	1457.2
298.15	5.0128	6.9152	11.928	2061.8	13.235	1494.6
300.00	5.0557	6.9543	12.010	2086.3	13.289	1516.7

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-45(CONT.)

THERMODYNAMIC FUNCTIONS FOR TITANIUM DIOXIDE (ANATASE) ($TI O_2$)
SOLID PHASE

GRAM MOLECULAR WT.= 79.90 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			(SOLID)			
300.00	5.0557	6.9543	12.010	2086.3	13.289	1516.7
310.00	5.2871	7.1634	12.451	2220.6	13.580	1639.0
320.00	5.5178	7.3683	12.886	2357.8	13.856	1765.7
330.00	5.7476	7.5688	13.316	2497.7	14.110	1896.7
340.00	5.9765	7.7646	13.741	2640.0	14.341	2032.0
350.00	6.2043	7.9556	14.160	2784.5	14.552	2171.5
360.00	6.4311	8.1416	14.573	2931.0	14.746	2315.2
370.00	6.6566	8.3225	14.979	3079.3	14.925	2463.0
373.15	6.7274	8.3781	15.106	3126.4	14.979	2510.3
380.00	6.8809	8.4985	15.379	3229.4	15.091	2614.8
390.00	7.1039	8.6695	15.773	3381.1	15.244	2770.5
400.00	7.3255	8.8357	16.161	3534.3	15.386	2930.2
425.00	7.8731	9.2305	17.104	3923.0	15.701	3346.1
450.00	8.4113	9.5975	18.009	4318.9	15.966	3785.1
475.00	8.9394	9.9388	18.878	4720.9	16.193	4246.2
500.00	9.4574	10.2570	19.714	5128.3	16.388	4728.7
550.00	10.462	10.829	21.292	5956.0	16.707	5754.3
600.00	11.427	11.330	22.756	6797.8	16.955	6856.0
650.00	12.351	11.770	24.122	7650.7	17.154	8028.3
700.00	13.238	12.161	25.399	8512.6	17.317	9266.7
750.00	14.089	12.509	26.598	9382.0	17.453	10567.
800.00	14.907	12.822	27.729	10258.	17.569	11925.
850.00	15.693	13.104	28.797	11139.	17.670	13339.
900.00	16.449	13.360	29.809	12024.	17.758	14804.
950.00	17.178	13.594	30.772	12914.	17.836	16319.
1000.00	17.881	13.808	31.688	13808.	17.907	17881.
1050.00	18.559	14.005	32.564	14705.	17.971	19487.
1100.00	19.215	14.186	33.401	15605.	18.030	21136.
1150.00	19.849	14.355	34.204	16508.	18.085	22827.
1200.00	20.463	14.511	34.975	17413.	18.136	24556.
1250.00	21.059	14.657	35.716	18321.	18.184	26323.
1300.00	21.636	14.794	36.430	19232.	18.230	28127.

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-46

THERMODYNAMIC FUNCTIONS FOR ZIRCONIUM (ZR)
SOLID PHASE

GRAM MOLECULAR WT.= 91.22 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL/DEG MOLE	CAL/DEG MOLE	CAL/DEG MOLE	CAL/MOLE	CAL/DEG MOLE	CAL/MOLE
			(SOLID)			
0.00	0.0000	0.0000	0.000	0.000	0.000	0.000
5.00	0.0009	0.0018	0.003	0.009	0.005	0.005
10.00	0.0038	0.0082	0.012	0.082	0.028	0.038
15.00	0.0097	0.0247	0.034	0.370	0.098	0.146
20.00	0.0211	0.0600	0.081	1.200	0.250	0.422
25.00	0.0404	0.117(	0.157	2.925	0.452	1.010
30.00	0.0683	0.1967	0.265	5.901	0.750	2.048
35.00	0.1061	0.3000	0.406	10.501	1.095	3.712
40.00	0.1539	0.4221	0.576	16.886	1.461	6.157
45.00	0.2114	0.5583	0.770	25.121	1.832	9.512
50.00	0.2777	0.7034	0.981	35.171	2.184	13.883
55.00	0.3517	0.8532	1.205	46.927	2.515	19.344
60.00	0.4324	1.0047	1.437	60.279	2.823	25.946
65.00	0.5188	1.1556	1.674	75.113	3.107	33.724
70.00	0.6099	1.3045	1.914	91.315	3.370	42.695
75.00	0.7049	1.4504	2.155	108.78	3.611	52.870
80.00	0.8031	1.5923	2.395	127.38	3.829	64.247
85.00	0.9038	1.7297	2.634	147.03	4.025	76.821
90.00	1.0064	1.8622	2.869	167.60	4.199	90.577
95.00	1.1105	1.9893	3.100	188.99	4.353	105.50
100.00	1.2157	2.1110	3.327	211.10	4.489	121.57
105.00	1.3215	2.2271	3.549	233.85	4.608	138.76
110.00	1.4277	2.3378	3.766	257.15	4.713	157.05
115.00	1.5340	2.4431	3.977	280.96	4.807	176.41
120.00	1.6401	2.5434	4.183	305.20	4.891	196.81
125.00	1.7458	2.6388	4.385	329.86	4.969	218.23
130.00	1.8511	2.7299	4.581	354.88	5.042	240.65
135.00	1.9558	2.8168	4.773	380.27	5.110	264.03
140.00	2.0598	2.8999	4.960	405.98	5.175	288.37
145.00	2.1629	2.9794	5.142	432.01	5.238	313.62
150.00	2.2652	3.0557	5.321	458.35	5.297	339.78
155.00	2.3666	3.1289	5.496	484.98	5.353	366.82
160.00	2.4671	3.1992	5.666	511.87	5.406	394.73
165.00	2.5665	3.2668	5.833	539.03	5.456	423.48
170.00	2.6650	3.3320	5.997	566.43	5.504	453.06
175.00	2.7625	3.3947	6.157	594.07	5.550	483.45
180.00	2.8590	3.4551	6.314	621.92	5.593	514.62
185.00	2.9545	3.5135	6.468	649.99	5.633	546.58
190.00	3.0489	3.5697	6.619	678.25	5.671	579.30
195.00	3.1424	3.6241	6.767	706.70	5.707	612.76
200.00	3.2348	3.6766	6.911	735.32	5.740	646.96
205.00	3.3262	3.7273	7.054	764.09	5.771	681.87
210.00	3.4166	3.7763	7.193	793.02	5.799	717.49
215.00	3.5060	3.8236	7.330	822.08	5.825	753.80
220.00	3.5945	3.869(	7.464	851.27	5.849	790.78
225.00	3.6819	3.9136	7.596	880.57	5.872	828.43
230.00	3.7684	3.9564	7.725	909.98	5.893	866.73
235.00	3.8539	3.9979	7.852	939.50	5.913	905.68
240.00	3.9385	4.0380	7.977	969.12	5.933	945.25
245.00	4.0222	4.0768	8.099	998.83	5.951	985.44
250.00	4.1049	4.1145	8.219	1028.6	5.969	1026.2
255.00	4.1868	4.1510	8.338	1058.5	5.986	1067.6
260.00	4.2677	4.1865	8.454	1088.5	6.002	1109.6
265.00	4.3478	4.2209	8.569	1118.5	6.017	1152.2
270.00	4.4270	4.2543	8.681	1148.6	6.032	1195.3
273.15	4.4765	4.2748	8.751	1167.7	6.040	1222.7
275.00	4.5054	4.2867	8.792	1178.8	6.045	1239.0
280.00	4.5829	4.3182	8.901	1209.1	6.059	1283.2
285.00	4.6596	4.3489	9.008	1239.4	6.072	1328.0
290.00	4.7355	4.3787	9.114	1269.8	6.085	1373.3
295.00	4.8106	4.4077	9.218	1300.3	6.097	1419.1
298.15	4.8575	4.4256	9.283	1319.5	6.105	1448.3
300.00	4.8849	4.4360	9.321	1330.8	6.110	1465.5

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-46 (CONT.)

THERMODYNAMIC FUNCTIONS FOR ZIRCONIUM (Zr): SOLID AND LIQUID PHASES

Gram Molecular Weight = 91.22 1 cal = 4.1840 abs j

T deg K = 273.15 + T deg C

T	$-(F_T^o-H_0^o)/T$	$(H_T^o-H_0^o)/T$	$S_T^o-S_0^o$	$H_T-H_0^o$	C_p^o	$-(F_T^o-H_0^o)$
deg K	cal / deg mole	cal / deg mole	cal / deg mole	cal / mole	cal / deg mole	cal / mole
			(SOLID-ALPHA)			
298.15	4.857	4.426	9.283	1319.5	6.105	1448
300	4.884	4.436	9.321	1331	6.110	1465
325	5.245	4.567	9.813	1484	6.175	1705
350	5.588	4.684	10.272	1640	6.239	1956
375	5.915	4.790	10.705	1796	6.304	2218
400	6.227	4.887	11.114	1954	6.369	2491
425	6.526	4.976	11.502	2115	6.433	2774
450	6.813	5.059	11.872	2276	6.498	3066
475	7.089	5.136	12.225	2440	6.563	3367
500	7.354	5.209	12.563	2604	6.628	3677
550	7.857	5.344	13.201	2939	6.757	4321
600	8.327	5.467	13.794	3280	6.886	4996
650	8.769	5.581	14.351	3628	7.016	5700
700	9.187	5.688	14.875	3982	7.145	6430
750	9.583	5.790	15.373	4342	7.274	7187
800	9.959	5.886	15.846	4709	7.404	7967
850	10.319	5.980	16.299	5083	7.533	8771
900	10.664	6.069	16.733	5462	7.662	9598
950	10.994	6.157	17.151	5848	7.792	10444
1000	11.312	6.242	17.554	6242	7.921	11312
1050	11.619	6.325	17.943	6640	8.050	12200
1100	11.915	6.406	18.321	7047	8.180	13106
1136	12.122	6.464	18.586	7342	8.273	13770
			(SOLID-BETA)			
1136	12.122	7.308	19.431	8302	6.683	13770
1150	12.212	7.301	19.513	8396	6.706	14044
1200	12.522	7.278	19.800	8733	6.786	15026
1250	12.819	7.260	20.078	9075	6.866	16024
1300	13.103	7.246	20.349	9420	6.946	17034
1350	13.376	7.237	20.613	9769	7.027	18058
1400	13.639	7.230	20.870	10123	7.107	19095
1450	13.893	7.228	21.121	10480	7.188	20145
1500	14.138	7.228	21.366	10842	7.268	21207
1550	14.375	7.230	21.605	11207	7.348	22281
1600	14.605	7.235	21.840	11576	7.429	23368
1650	14.827	7.242	22.070	11950	7.509	24464
1700	15.044	7.251	22.295	12327	7.589	25575
1750	15.254	7.262	22.516	12709	7.670	26694
1800	15.459	7.274	22.733	13094	7.750	27826
1850	15.659	7.288	22.947	13483	7.830	28969
1900	15.853	7.304	23.157	13877	7.910	30121
1950	16.043	7.320	23.363	14275	7.991	31284
2000	16.229	7.338	23.567	14676	8.071	32458
2050	16.410	7.357	23.767	15082	8.151	33640
2100	16.587	7.377	23.964	15491	8.232	34833
2130	16.692	7.389	24.081	15739	8.280	35554
			(LIQUID)			
2130	16.692	9.291	25.983	19789	7.800	35554
2150	16.779	9.277	26.056	19945	7.784	36075
2200	16.992	9.242	26.234	20333	7.744	37382
2250	17.199	9.209	26.408	20719	7.704	38698
2300	17.401	9.175	26.577	21104	7.664	40022
2350	17.598	9.143	26.741	21486	7.624	41355
2400	17.790	9.111	26.901	21866	7.584	42696
2450	17.978	9.079	27.057	22244	7.544	44046
2500	18.161	9.048	27.209	22620	7.504	45402
2600	18.515	8.987	27.502	23367	7.424	48139
2700	18.853	8.928	27.781	24105	7.344	50903
2800	19.176	8.870	28.046	24836	7.264	53693
2900	19.487	8.813	28.300	25558	7.184	56512
3000	19.784	8.757	28.542	26272	7.104	59352
3100	20.071	8.703	28.774	26979	7.024	62220
3200	20.346	8.649	28.995	27677	6.944	65107
3300	20.611	8.596	29.208	28368	6.864	68016
3400	20.867	8.544	29.411	29050	6.784	70948
3500	21.114	8.493	29.607	29724	6.704	73899

H_0 and S_0 apply to the reference state of the solid at zero deg K.

TABLE B-47

THERMODYNAMIC FUNCTIONS FOR A ZIRCONIUM HYDRIDE ($ZrH_{0.25}$): SOLID PHASES

Gram Molecular Weight = 91.47 grams 1 cal = 4.1840 abs j

T deg K = 273.15 + T deg C

T	$-(F^\circ_T-H^\circ_{298})/T$	$(H^\circ_T-H^\circ_{298})/T$	S°_T	$(H^\circ_T-H^\circ_{298})$	C°_p	$-(F^\circ_T-H^\circ_{298})$
deg K	cal / deg mole	cal / deg mole	cal / deg mole	cal / mole	cal / deg mole	cal / mole
			(SOLID-"ALPHA")			
298.15	9.053	0.000	9.053	0.	6.538	2669.
300	9.054	0.040	9.094	12.	6.543	2716.
325	9.077	.544	9.621	177.	6.642	2950.
350	9.134	.984	10.118	344.	6.777	3197.
375	9.215	1.376	10.591	515.	6.936	3456.
400	9.316	1.729	11.044	691.	7.113	3726.
425	9.430	2.051	11.481	871.	7.305	4008.
450	9.556	2.348	11.904	1056.	7.509	4300.
475	9.690	2.626	12.316	1247.	7.723	4603.
500	9.832	2.886	12.718	1443.	7.942	4916.
550	10.130	3.366	13.496	1851.	8.393	5571.
600	10.442	3.804	14.246	2282.	8.850	6265.
650	10.762	4.210	14.973	2736.	9.324	6996.
700	11.089	4.594	15.683	3215.	9.857	7762.
750	11.418	4.966	16.385	3724.	10.532	8564.
800	11.751	5.342	17.093	4273.	11.485	9401.
823.2	11.907	5.523	17.430	4546.	12.075	9802.
			(SOLID-"BETA")			
823.2	11.907	6.457	18.364	5316.	20.074	9802.
850	12.121	6.885	19.006	5852.	20.074	10303.
900	12.535	7.618	20.153	6856.	20.074	11282.
950	12.955	7.817	20.772	7426.	7.906	12307.
1000	13.357	7.821	21.178	7821.	7.906	13357.
1050	13.739	7.825	21.564	8216.	7.906	14426.
1100	14.102	7.829	21.931	8612.	7.906	15512.
1150	14.451	7.832	22.283	9007.	7.906	16619.
1200	14.784	7.835	22.619	9402.	7.906	17741.

H°_{298} (which actually should be read $H^\circ_{298.15}$) applies to the reference state of the solid at 298.15 deg K.

TABLE B-48

THERMODYNAMIC FUNCTIONS FOR A ZIRCONIUM HYDRIDE ($ZrH_{0.50}$): SOLID PHASES

Gram Molecular Weight = 91.72 grams 1 cal = 4.1840 abs j

T deg K = 273.15 + T deg C

T	$-(F^{\circ}_T-H^{\circ}_{298})/T$	$(H^{\circ}_T-H^{\circ}_{298})/T$	S°_T	$(H^{\circ}_T-H^{\circ}_{298})$	C°_p	$-(F^{\circ}_T-H^{\circ}_{298})$
deg K	cal / deg mole	cal / deg mole	cal / deg mole	cal / mole	cal / deg mole	cal / mole
			(SOLID-"ALPHA")			
298.15	8.885	0.000	8.885	0.	6.751	2642.
300	8.885	0.042	8.926	12.	6.761	2659.
325	8.909	0.564	9.474	183.	6.924	2889.
350	8.968	1.026	9.994	359.	7.135	3133.
375	9.053	1.441	10.495	540.	7.378	3390.
400	9.159	1.820	10.979	728.	7.643	3658.
425	9.280	2.171	11.451	923.	7.922	3939.
450	9.413	2.498	11.912	1124.	8.206	4232.
475	9.557	2.806	12.363	1333.	8.488	4535.
500	9.708	3.097	12.805	1549.	8.763	4850.
550	10.029	3.636	13.665	2000.	9.274	5512.
600	10.367	4.125	14.492	2475.	9.729	6217.
650	10.715	4.573	15.288	2972.	10.168	6962.
700	11.069	4.991	16.060	3493.	10.701	7745.
750	11.427	5.397	16.824	4047.	11.531	8568.
800	11.789	5.821	17.610	4657.	12.967	9428.
823.2	11.959	6.035	17.994	4968.	13.956	9845.
			(SOLID-"BETA")			
823.2	11.959	8.237	20.196	6781.	36.800	9845.
850	12.233	8.733	20.966	7423.	10.316	10398.
900	12.734	8.821	21.555	7938.	10.316	11461.
950	13.214	8.899	22.113	8454.	10.316	12553.
1000	13.672	8.970	22.642	8970.	10.316	13672.
1050	14.111	9.034	23.145	9486.	10.316	14817.
1100	14.533	9.092	23.625	10002.	10.316	15986.
1150	14.938	9.146	24.084	10518.	10.316	17179.
1200	15.329	9.194	24.523	11033.	10.316	18395.

H°_{298} (which actually should be read $H^{\circ}_{298.15}$) applies to the reference state of the solid at 298.15 deg K.

TABLE B-49

THERMODYNAMIC FUNCTIONS FOR A ZIRCONIUM HYDRIDE ($ZrH_{0.75}$): SOLID PHASES

Gram Molecular Weight = 91.98 grams 1 cal = 4.1840 abs j

T deg K = 273.15 + T deg C

T	$-(F^\circ_T-H^\circ_{298})/T$	$(H^\circ_T-H^\circ_{298})/T$	S°_T	$(H^\circ_T-H^\circ_{298})$	C°_p	$-(F^\circ_T-H^\circ_{298})$
deg K	cal / deg mole	cal / deg mole	cal / deg mole	cal / mole	cal / deg mole	cal / mole
			(SOLID-"ALPHA")			
298.15	8.716	0.000	8.716	0.	6.966	2599.
300	8.716	.043	8.759	13.	6.979	2615.
325	8.741	.585	9.326	190.	7.205	2841.
350	8.802	1.068	9.870	374.	7.492	3081.
375	8.891	1.507	10.398	565.	7.821	3334.
400	9.001	1.912	10.913	765.	8.174	3601.
425	9.129	2.291	11.420	974.	8.538	3880.
450	9.271	2.648	11.919	1192.	8.902	4172.
475	9.423	2.987	12.410	1419.	9.254	4476.
500	9.584	3.309	12.893	1654.	9.584	4792.
550	9.928	3.906	13.834	2148.	10.156	5460.
600	10.292	4.446	14.738	2668.	10.608	6175.
650	10.667	4.936	15.603	3208.	11.011	6933.
700	11.050	5.387	16.437	3771.	11.546	7734.
750	11.436	5.827	17.263	4370.	12.531	8577.
800	11.826	6.300	18.126	5040.	14.450	9461.
823.2	12.011	6.547	18.558	5390.	15.837	9887.
			(SOLID-"BETA")			
823.2	12.011	8.522	20.533	7015.	30.387	9887.
850	12.289	9.153	21.442	7780.	26.801	10446.
900	12.815	9.794	22.609	8814.	11.041	11534.
950	13.347	9.859	23.206	9366.	11.041	12680.
1000	13.854	9.918	23.772	9918.	11.041	13854.
1050	14.339	9.972	24.311	10470.	11.041	15056.
1100	14.805	10.020	24.825	11022.	11.041	16286.
1150	15.251	10.065	25.316	11574.	11.041	17539.
1200	15.680	10.105	25.785	12126.	11.041	18816.

H°_{298} (which actually should read $H^\circ_{298.15}$) applies to the reference state of the solid at 298.15 deg K.

TABLE B-50

THERMODYNAMIC FUNCTIONS FOR A ZIRCONIUM HYDRIDE ($ZrH_{1.00}$): SOLID PHASES

Gram Molecular Weight = 92.23 grams 1 cal = 4.1840 abs j

T deg K = 273.15 + T deg C

T	$-(F^{\circ}_T-H^{\circ}_{298})/T$	$(H^{\circ}_T-H^{\circ}_{298})/T$	S°_T	$(H^{\circ}_T-H^{\circ}_{298})$	C°_p	$-(F^{\circ}_T-H^{\circ}_{298})$
deg K	cal / deg mole	cal / deg mole	cal / deg mole	cal / mole	cal / deg mole	cal / mole
			(SOLID-"ALPHA")			
298.15	8.547	0.000	8.547	0.	7.180	2548.
300	8.547	0.044	8.591	13.	7.197	2564.
325	8.573	0.605	9.178	197.	7.486	2786.
350	8.636	1.109	9.746	388.	7.850	3023.
375	8.729	1.572	10.301	590.	8.263	3273.
400	8.845	2.004	10.849	802.	8.704	3538.
425	8.979	2.411	11.390	1025.	9.155	3816.
450	9.127	2.796	11.926	1259.	9.598	4107.
475	9.289	3.167	12.456	1504.	10.019	4412.
500	9.460	3.520	12.980	1760.	10.405	4730.
550	9.827	4.176	14.003	2297.	11.037	5405.
600	10.216	4.768	14.984	2860.	11.487	6130.
650	10.619	5.298	15.918	3444.	11.854	6902.
700	11.030	5.784	16.814	4049.	12.391	7721.
750	11.445	6.257	17.702	4693.	13.531	8584.
800	11.865	6.778	18.643	5423.	15.932	9492.
823.2	12.064	7.059	19.123	5812.	17.718	9931.
			(SOLID-"BETA")			
823.2	12.064	7.812	19.876	6431.	31.208	9931.
850	12.318	8.493	20.811	7219.	27.626	10470.
900	12.821	9.413	22.234	8472.	22.832	11539.
950	13.339	10.029	23.368	9528.	19.605	12672.
1000	13.859	10.448	24.307	10448.	17.338	13859.
1050	14.372	10.735	25.107	11272.	15.695	15091.
1100	14.837	10.931	25.768	12024.	11.046	16321.
1150	15.324	10.936	26.260	12576.	11.046	17623.
1200	15.789	10.941	26.730	13129.	11.046	18947.

H°_{298} (which actually should read $H^{\circ}_{298.15}$) applies to the reference state of the solid at 298.15 deg K.

TABLE B-51

THERMODYNAMIC FUNCTIONS FOR A ZIRCONIUM HYDRIDE ($ZrH_{1.25}$): SOLID PHASES

Gram Molecular Weight = 92.48 grams 1 cal = 4.1840 abs j

T deg K = 273.15 + T deg C

T	$-(F^{\circ}_T-H^{\circ}_{298})/T$	$(H^{\circ}_T-H^{\circ}_{298})/T$	S°_T	$(H^{\circ}_T-H^{\circ}_{298})$	C°_p	$-(F^{\circ}_T-H^{\circ}_{298})$
deg K	cal / deg mole	cal / deg mole	cal / deg mole	cal / mole	cal / deg mole	cal / mole
298.15	8.378	0.000	8.378	0.	7.394	2498.
300	8.378	0.046	8.424	14.	7.415	2513.
325	8.405	0.625	9.031	203.	7.767	2732.
350	8.471	1.151	9.622	403.	8.208	2965.
375	8.567	1.638	10.205	614.	8.705	3213.
400	8.688	2.096	10.783	838.	9.234	3475.
425	8.828	2.531	11.359	1076.	9.772	3752.
450	8.984	2.948	11.933	1327.	10.294	4043.
475	9.155	3.348	12.503	1590.	10.784	4348.
500	9.336	3.731	13.067	1866.	11.226	4668.
550	9.726	4.446	14.172	2445.	11.918	5349.
600	10.141	5.089	15.230	3053.	12.366	6084.
650	10.571	5.661	16.232	3680.	12.697	6871.
700	11.010	6.180	17.190	4326.	13.236	7707.
750	11.454	6.688	18.141	5016.	14.531	8590.
800	11.903	7.257	19.160	5806.	17.414	9522.
850	12.348	7.832	20.180	6657.	28.451	10496.
900	12.815	8.835	21.650	7952.	23.662	11534.
950	13.304	9.525	22.829	9049.	20.440	12639.
1000	13.800	10.012	23.812	10012.	18.179	13800.
1050	14.293	10.359	24.652	10877.	16.541	15008.
1100	14.782	10.611	25.393	11672.	15.324	16260.
1150	15.254	10.795	26.049	12415.	14.402	17542.
1200	15.717	10.930	26.647	13116.	13.694	18860.

H°_{298} (which actually should read $H^{\circ}_{298.15}$) applies to the reference state of the solid at 298.15 deg K.

TABLE B-52

THERMODYNAMIC FUNCTIONS FOR ZIRCONIUM DIOXIDE (ZrO_2)
SOLID PHASES

GRAM MOLECULAR WT.=123.22 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			SOLID PHASE (ALPHA)			
0.00	0.	0.	0.	0.	0.	0.
5.00	0.0000	0.0002	0.000	0.001	0.001	0.000
10.00	0.0008	0.003(	0.004	0.030	0.012	0.008
15.00	0.0032	0.0101	0.013	0.151	0.039	0.048
20.00	0.0077	0.0230	0.031	0.460	0.089	0.154
25.00	0.0149	0.0439	0.059	1.097	0.172	0.373
30.00	0.0255	0.0749	0.100	2.246	0.295	0.765
35.00	0.0401	0.1177	0.158	4.118	0.461	1.403
40.00	0.0593	0.1733	0.233	6.933	0.671	2.371
45.00	0.0835	0.2421	0.326	10.896	0.919	3.758
50.00	0.1131	0.3236	0.437	16.179	1.198	5.657
55.00	0.1483	0.4166	0.565	22.912	1.499	8.154
60.00	0.1889	0.5198	0.709	31.189	1.814	11.331
65.00	0.2348	0.6319	0.867	41.071	2.140	15.264
70.00	0.2860	0.7514	1.037	52.598	2.472	20.019
75.00	0.3421	0.8773	1.219	65.796	2.808	25.657
80.00	0.4029	1.0086	1.411	80.684	3.148	32.230
85.00	0.4681	1.1444	1.613	97.278	3.490	39.786
90.00	0.5374	1.2843	1.822	115.59	3.834	48.369
95.00	0.6107	1.4276	2.038	135.62	4.179	58.016
100.00	0.6876	1.5738	2.261	157.38	4.524	68.762
105.00	0.7680	1.7224	2.490	180.85	4.866	80.640
110.00	0.8516	1.8730	2.725	206.03	5.204	93.675
115.00	0.9382	2.0251	2.963	232.89	5.537	107.89
120.00	1.0276	2.1783	3.206	261.39	5.865	123.31
125.00	1.1197	2.3322	3.452	291.53	6.187	139.96
130.00	1.2141	2.4866	3.701	323.26	6.503	157.84
135.00	1.3109	2.6411	3.952	356.55	6.814	176.97
140.00	1.4097	2.7956	4.205	391.38	7.118	197.36
145.00	1.5105	2.9498	4.460	427.72	7.416	219.03
150.00	1.6131	3.1036	4.717	465.53	7.708	241.97
155.00	1.7174	3.2567	4.974	504.78	7.992	266.19
160.00	1.8232	3.4090	5.232	545.44	8.268	291.71
165.00	1.9304	3.5603	5.491	587.46	8.537	318.52
170.00	2.0389	3.7106	5.750	630.80	8.798	346.62
175.00	2.1486	3.8596	6.008	675.43	9.052	376.01
180.00	2.2594	4.0072	6.267	721.30	9.298	406.70
185.00	2.3712	4.1535	6.525	768.40	9.537	438.68
190.00	2.4839	4.2983	6.782	816.67	9.770	471.95
195.00	2.5974	4.4415	7.039	866.09	9.997	506.50
200.00	2.7117	4.5831	7.295	916.62	10.217	542.33
205.00	2.8266	4.723[	7.550	968.24	10.430	579.44
210.00	2.9420	4.8615	7.804	1020.9	10.638	617.83
215.00	3.0580	4.9982	8.056	1074.6	10.839	657.48
220.00	3.1745	5.1332	8.308	1129.3	11.034	698.39
225.00	3.2913	5.2664	8.558	1184.9	11.224	740.55
230.00	3.4085	5.3979	8.806	1241.5	11.407	783.96
235.00	3.5260	5.5277	9.054	1299.0	11.584	828.61
240.00	3.6437	5.6556	9.299	1357.4	11.755	874.50
245.00	3.7617	5.7818	9.543	1416.5	11.919	921.61
250.00	3.8797	5.9061	9.786	1476.5	12.078	969.93
255.00	3.9979	6.0287	10.027	1537.3	12.230	1019.5
260.00	4.1161	6.1493	10.265	1598.8	12.378	1070.2
265.00	4.2344	6.2682	10.503	1661.1	12.522	1122.1
270.00	4.3527	6.3854	10.738	1724.0	12.663	1175.2
273.15	4.4271	6.4583	10.885	1764.1	12.751	1209.3
275.00	4.4709	6.5008	10.972	1787.7	12.801	1229.5
280.00	4.5890	6.6145	11.204	1852.1	12.938	1284.9
285.00	4.7071	6.7266	11.434	1917.1	13.072	1341.5
290.00	4.8250	6.8371	11.662	1982.8	13.203	1399.3
295.00	4.9429	6.9461	11.889	2049.1	13.332	1458.1
298.15	5.0170	7.0140	12.031	2091.2	13.412	1495.8
300.00	5.0605	7.0536	12.114	2116.1	13.458	1518.2

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-52(CONT.)

THERMODYNAMIC FUNCTIONS FOR ZIRCONIUM DIOXIDE (ZrO_2)
SOLID PHASES

GRAM MOLECULAR WT.=123.22 GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL/DEG MOLE	CAL/DEG MOLE	CAL/DEG MOLE	CAL/MOLE	CAL/DEG MOLE	CAL/MOLE
			SOLID PHASE (ALPHA)			
300.00	5.0605	7.0536	12.114	2116.1	13.458	1518.2
310.00	5.2952	7.2642	12.559	2251.9	13.702	1641.5
320.00	5.5291	7.4690	12.998	2390.1	13.933	1769.3
330.00	5.7620	7.6682	13.430	2530.5	14.148	1901.5
340.00	5.9938	7.8617	13.856	2673.0	14.345	2037.9
350.00	6.2244	8.0496	14.274	2817.4	14.527	2178.6
360.00	6.4538	8.2319	14.686	2963.5	14.695	2323.4
370.00	6.6817	8.4087	15.090	3111.2	14.852	2472.2
373.15	6.7533	8.4633	15.217	3158.1	14.899	2520.0
380.00	6.9083	8.5802	15.489	3260.5	14.997	2625.1
390.00	7.1333	8.7465	15.880	3411.1	15.133	2782.0
400.00	7.3568	8.9078	16.265	3563.1	15.260	2942.7
425.00	7.9084	9.2900	17.198	3948.3	15.545	3361.1
450.00	8.4496	9.6445	18.094	4340.0	15.791	3802.3
475.00	8.9800	9.9738	18.954	4737.5	16.006	4265.5
500.00	9.5000	10.280	19.780	5140.0	16.196	4749.9
550.00	10.506	10.833	21.339	5958.2	16.519	5778.4
600.00	11.470	11.318	22.788	6791.0	16.787	6882.0
650.00	12.393	11.748	24.141	7636.2	17.015	8055.6
700.00	13.278	12.132	25.410	8492.1	17.214	9294.7
700.00	13.278	12.132	25.410	8492.1	17.214	9994.7
750.00	14.127	12.476	26.604	9357.3	17.393	10595.
800.00	14.942	12.789	27.731	10231.	17.555	11954.
850.00	15.726	13.074	28.800	11113.	17.705	13367.
900.00	16.481	13.335	29.816	12001.	17.845	14833.
950.00	17.209	13.576	30.784	12897.	17.978	16348.
1000.00	17.911	13.787	31.697	13787.	18.104	17911.
1050.00	18.588	13.983	32.571	14682.	18.225	19517.
1100.00	19.243	14.179	33.422	15597.	18.342	21167.
1150.00	19.877	14.362	34.240	16516.	18.456	22859.
1200.00	20.492	14.535	35.027	17442.	18.567	24591.
1250.00	21.089	14.699	35.788	18373.	18.675	26361.
1300.00	21.669	14.853	36.522	19310.	18.781	28169.
1350.00	22.232	15.001	37.233	20251.	18.886	30013.
1400.00	22.780	15.141	37.921	21198.	18.989	31892.
1450.00	23.314	15.276	38.590	22150.	19.090	33805.
1478.00	23.607	15.348	38.955	22685.	19.147	34891.
			SOLID PHASE (BETA)			
1478.00	23.607	16.309	39.916	24105.	17.800	34891.
1500.00	23.848	16.331	40.179	24497.	17.800	35772.
1550.00	24.383	16.379	40.762	25387.	17.800	37794.
1600.00	24.904	16.423	41.327	26277.	17.800	39846.
1650.00	25.410	16.465	41.875	27167.	17.800	41927.
1700.00	25.902	16.504	42.406	28057.	17.800	44033.
1750.00	26.381	16.541	42.922	28947.	17.800	46166.
1800.00	26.848	16.576	43.424	29837.	17.800	48326.
1850.00	27.303	16.609	43.912	30727.	17.800	50510.
1900.00	27.746	16.640	44.386	31617.	17.800	52716.
1950.00	28.178	16.670	44.848	32507.	17.800	54947.
2000.00	28.601	16.698	45.299	33397.	17.800	57201.

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-53

THERMODYNAMIC FUNCTIONS FOR ZIRCONIUM NITRIDE (ZR N)
SOLID PHASE

GRAM MOLECULAR WT.=105.228GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			(SOLID)			
0.00	0.	0.	0.	0.	0.	0.
5.00	0.0000	0.0002	0.000	0.001	0.001	0.000
10.00	0.0007	0.0026	0.003	0.026	0.011	0.007
15.00	0.0028	0.0088	0.012	0.132	0.034	0.042
20.00	0.0068	0.0202	0.027	0.405	0.079	0.136
25.00	0.0131	0.0387	0.052	0.968	0.152	0.328
30.00	0.0225	0.0661	0.089	1.983	0.260	0.674
35.00	0.0353	0.1039	0.139	3.636	0.407	1.237
40.00	0.0523	0.1529	0.205	6.114	0.590	2.091
45.00	0.0736	0.2131	0.287	9.591	0.805	3.314
50.00	0.0997	0.2842	0.384	14.212	1.047	4.984
55.00	0.1305	0.3653	0.496	20.092	1.308	7.177
60.00	0.1661	0.4552	0.621	27.314	1.583	9.964
65.00	0.2063	0.5528	0.759	35.929	1.864	13.411
70.00	0.2510	0.6565	0.908	45.956	2.147	17.573
75.00	0.3000	0.7652	1.065	57.391	2.426	22.502
80.00	0.3530	0.8776	1.231	70.205	2.699	28.238
85.00	0.4096	0.9925	1.402	84.363	2.963	34.818
90.00	0.4697	1.1092	1.579	99.826	3.221	42.268
95.00	0.5328	1.2269	1.760	116.56	3.471	50.613
100.00	0.5987	1.3453	1.944	134.53	3.716	59.871
105.00	0.6672	1.4639	2.131	153.71	3.957	70.058
110.00	0.7381	1.5826	2.321	174.09	4.192	81.186
115.00	0.8110	1.7011	2.512	195.63	4.424	93.267
120.00	0.8859	1.8193	2.705	218.32	4.651	106.31
125.00	0.9626	1.9370	2.900	242.13	4.873	120.32
130.00	1.0408	2.0542	3.095	267.04	5.091	135.31
135.00	1.1205	2.1706	3.291	293.04	5.305	151.27
140.00	1.2016	2.2863	3.488	320.08	5.513	168.22
145.00	1.2838	2.4011	3.685	348.16	5.717	186.15
150.00	1.3671	2.5149	3.882	377.24	5.914	205.07
155.00	1.4514	2.6277	4.079	407.29	6.107	224.97
160.00	1.5366	2.7393	4.276	438.29	6.293	245.86
165.00	1.6226	2.8498	4.472	470.21	6.474	267.73
170.00	1.7093	2.9589	4.668	503.02	6.648	290.58
175.00	1.7966	3.0668	4.863	536.69	6.818	314.41
180.00	1.8845	3.1733	5.058	571.19	6.982	339.22
185.00	1.9729	3.2784	5.251	606.50	7.142	364.99
190.00	2.0617	3.3821	5.444	642.60	7.296	391.73
195.00	2.1509	3.4844	5.635	679.46	7.446	419.43
200.00	2.2404	3.5853	5.826	717.05	7.592	448.08
205.00	2.3302	3.6847	6.015	755.37	7.733	477.68
210.00	2.4201	3.7827	6.203	794.37	7.869	508.23
215.00	2.5103	3.8793	6.390	834.05	8.002	539.71
220.00	2.6005	3.9745	6.575	874.38	8.130	572.12
225.00	2.6909	4.0682	6.759	915.34	8.254	605.46
230.00	2.7813	4.1605	6.942	956.91	8.374	639.71
235.00	2.8718	4.2514	7.123	999.07	8.490	674.87
240.00	2.9622	4.3408	7.303	1041.8	8.601	710.94
245.00	3.0527	4.4289	7.482	1085.1	8.709	747.90
250.00	3.1430	4.5156	7.659	1128.9	8.814	785.75
255.00	3.2333	4.6008	7.834	1173.2	8.914	824.48
260.00	3.3234	4.6847	8.008	1218.0	9.012	864.09
265.00	3.4134	4.7673	8.181	1263.3	9.107	904.56
270.00	3.5033	4.8485	8.352	1309.1	9.199	945.89
273.15	3.5598	4.8990	8.459	1338.2	9.256	972.37
275.00	3.5930	4.9284	8.521	1355.3	9.289	988.08
280.00	3.6825	5.0070	8.690	1402.0	9.376	1031.1
285.00	3.7718	5.0844	8.856	1449.1	9.460	1075.0
290.00	3.8609	5.1606	9.021	1496.6	9.541	1119.7
295.00	3.9498	5.2355	9.185	1544.5	9.618	1165.2
298.15	4.0056	5.2820	9.288	1574.8	9.666	1194.3
300.00	4.0384	5.3092	9.347	1592.7	9.693	1211.5

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-53(CONT.)

THERMODYNAMIC FUNCTIONS FOR ZIRCONIUM NITRIDE (ZR N)
SOLID PHASE

GRAM MOLECULAR WT.=105.228GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			(SOLID)			
300.00	4.0384	5.3092	9.347	1592.7	9.693	1211.5
310.00	4.2148	5.4528	9.668	1690.4	9.831	1306.6
320.00	4.3902	5.5917	9.982	1789.3	9.958	1404.8
330.00	4.5643	5.7258	10.290	1889.5	10.075	1506.2
340.00	4.7371	5.8553	10.592	1990.8	10.183	1610.6
350.00	4.9087	5.9804	10.889	2093.1	10.284	1718.0
360.00	5.0789	6.1013	11.180	2196.5	10.378	1828.4
370.00	5.2476	6.2180	11.466	2300.7	10.465	1941.6
373.15	5.3005	6.2540	11.555	2333.7	10.492	1977.9
380.00	5.4150	6.3309	11.746	2405.7	10.547	2057.7
390.00	5.5808	6.4400	12.021	2511.6	10.624	2176.5
400.00	5.7452	6.5455	12.291	2618.2	10.697	2298.1
425.00	6.1496	6.7947	12.944	2887.7	10.861	2613.6
450.00	6.5446	7.0247	13.569	3161.1	11.007	2945.1
475.00	6.9302	7.2378	14.168	3437.9	11.136	3291.8
500.00	7.3065	7.4356	14.742	3717.8	11.252	3653.3
550.00	8.0322	7.7920	15.824	4285.6	11.455	4417.7
600.00	8.7239	8.1048	16.829	4862.9	11.630	5234.3
650.00	9.3838	8.3820	17.766	5448.3	11.785	6099.4
700.00	10.014	8.6301	18.644	6041.1	11.925	7009.9
750.00	10.617	8.8542	19.472	6640.6	12.054	7963.0
800.00	11.195	9.0580	20.253	7246.4	12.175	8956.3
850.00	11.750	9.2448	20.995	7858.0	12.290	9987.7
900.00	12.284	9.4170	21.701	8475.3	12.400	11055.
950.00	12.797	9.5768	22.374	9097.9	12.505	12157.
1000.00	13.292	9.7258	23.018	9725.8	12.608	13292.
1050.00	13.770	9.8654	23.635	10359.	12.708	14459.
1100.00	14.232	9.9968	24.229	10997.	12.806	15655.
1150.00	14.679	10.121	24.800	11639.	12.902	16881.
1200.00	15.112	10.239	25.351	12287.	12.997	18135.
1250.00	15.533	10.351	25.884	12939.	13.090	19416.
1300.00	15.941	10.458	26.399	13596.	13.182	20723.
1350.00	16.337	10.561	26.898	14257.	13.274	22056.
1400.00	16.723	10.659	27.383	14923.	13.364	23413.
1450.00	17.099	10.754	27.853	15593.	13.454	24794.
1500.00	17.465	10.846	28.311	16268.	13.544	26198.
1550.00	17.822	10.934	28.756	16948.	13.632	27624.
1600.00	18.171	11.020	29.191	17632.	13.721	29073.
1650.00	18.511	11.103	29.614	18320.	13.809	30543.
1700.00	18.844	11.184	30.028	19013.	13.896	32034.

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-54

THERMODYNAMIC FUNCTIONS FOR ZIRCONIUM TETRACHLORIDE ($ZrCl_4$)
SOLID PHASE

GRAM MOLECULAR WT.=233.048GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			(SOLID)			
0.00	0.	0.	0.	0.	0.	0.
5.00	0.0048	0.0256	0.030	0.128	0.146	0.024
10.00	0.0897	0.2956	0.385	2.956	1.075	0.897
15.00	0.2919	0.7509	1.043	11.264	2.262	4.378
20.00	0.5794	1.2817	1.861	25.634	3.490	11.588
25.00	0.9260	1.8472	2.773	46.179	4.730	23.150
30.00	1.3143	2.4313	3.746	72.938	5.973	39.428
35.00	1.7336	3.0256	4.759	105.90	7.207	60.677
40.00	2.1767	3.6239	5.801	144.95	8.411	87.068
45.00	2.6380	4.2206	6.859	189.93	9.569	118.71
50.00	3.1134	4.8109	7.924	240.54	10.667	155.67
55.00	3.5992	5.3906	8.990	296.48	11.699	197.96
60.00	4.0926	5.9570	10.050	357.42	12.665	245.56
65.00	4.5913	6.5082	11.100	423.03	13.571	298.44
70.00	5.0933	7.0434	12.137	493.04	14.422	356.53
75.00	5.5970	7.5622	13.159	567.17	15.222	419.78
80.00	6.1012	8.0647	14.166	645.18	15.974	488.10
85.00	6.6048	8.5510	15.156	726.84	16.682	561.41
90.00	7.1070	9.0215	16.128	811.93	17.350	639.63
95.00	7.6070	9.4766	17.084	900.28	17.982	722.67
100.00	8.1044	9.9170	18.021	991.70	18.585	810.44
105.00	8.5986	10.344	18.942	1086.1	19.163	902.85
110.00	9.0894	10.757	19.847	1183.3	19.717	999.83
115.00	9.5764	11.158	20.735	1283.2	20.248	1101.3
120.00	10.060	11.548	21.607	1385.7	20.755	1207.2
125.00	10.539	11.926	22.464	1490.7	21.235	1317.3
130.00	11.014	12.293	23.306	1598.0	21.689	1431.6
135.00	11.484	12.649	24.133	1707.6	22.117	1550.4
140.00	11.951	12.994	24.945	1819.2	22.519	1673.1
145.00	12.412	13.329	25.742	1932.7	22.899	1799.8
150.00	12.870	13.654	26.524	2048.1	23.256	1930.5
155.00	13.323	13.969	27.292	2165.2	23.592	2065.0
160.00	13.771	14.275	28.046	2284.0	23.909	2203.4
165.00	14.215	14.572	28.786	2404.3	24.209	2345.4
170.00	14.654	14.859	29.513	2526.1	24.491	2491.2
175.00	15.089	15.138	30.227	2649.2	24.758	2640.6
180.00	15.519	15.409	30.928	2773.6	25.010	2793.5
185.00	15.945	15.672	31.617	2899.3	25.249	2949.8
190.00	16.366	15.927	32.293	3026.1	25.475	3109.6
195.00	16.783	16.174	32.958	3154.0	25.690	3272.7
200.00	17.196	16.415	33.611	3283.0	25.894	3439.2
205.00	17.604	16.648	34.252	3412.9	26.087	3608.8
210.00	18.008	16.875	34.883	3543.8	26.272	3781.7
215.00	18.408	17.096	35.504	3675.6	26.448	3957.6
220.00	18.803	17.310	36.114	3808.3	26.616	4136.7
225.00	19.194	17.519	36.713	3941.8	26.777	4318.8
230.00	19.582	17.722	37.304	4076.0	26.931	4503.8
235.00	19.965	17.919	37.884	4211.1	27.079	4691.8
240.00	20.344	18.112	38.456	4346.8	27.221	4882.6
245.00	20.720	18.299	39.019	4483.3	27.359	5076.3
250.00	21.091	18.482	39.573	4620.4	27.493	5272.8
255.00	21.459	18.660	40.119	4758.2	27.622	5472.0
260.00	21.823	18.833	40.656	4896.6	27.749	5674.0
265.00	22.183	19.003	41.186	5035.7	27.873	5878.6
270.00	22.540	19.168	41.708	5175.3	27.994	6085.8
273.15	22.763	19.270	42.033	5263.6	28.070	6217.7
275.00	22.893	19.330	42.223	5315.6	28.114	6295.7
280.00	23.243	19.487	42.730	5456.5	28.233	6508.0
285.00	23.589	19.642	43.231	5597.9	28.349	6722.9
290.00	23.932	19.793	43.725	5740.0	28.464	6940.3
295.00	24.272	19.941	44.213	5882.6	28.576	7160.2
298.15	24.484	20.033	44.517	5972.7	28.645	7299.9
300.00	24.608	20.086	44.694	6025.7	28.685	7382.5

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

TABLE B-54(CONT.)

THERMODYNAMIC FUNCTIONS FOR ZIRCONIUM TETRACHLORIDE ($ZR\ CL_4$)
SOLID PHASE

GRAM MOLECULAR WT.=233.048GRAMS 1 CAL=4.1840 ABS J

T DEG K = 273.15 + T DEG C

T	$-(F_T^0-H_0^0)/T$	$(H_T^0-H_0^0)/T$	$(S_T^0-S_0^0)$	$(H_T^0-H_0^0)$	C_P^0	$-(F_T^0-H_0^0)$
DEG K	CAL / DEG MOLE	CAL / DEG MOLE	CAL / DEG MOLE	CAL / MOLE	CAL / DEG MOLE	CAL / MOLE
			(SOLID)			
300.00	24.608	20.086	44.694	6025.7	28.685	7382.5
310.00	25.271	20.367	45.638	6313.6	28.891	7834.1
320.00	25.922	20.636	46.558	6603.5	29.078	8295.1
330.00	26.561	20.894	47.456	6895.1	29.248	8765.2
340.00	27.189	21.142	48.331	7188.4	29.403	9244.2
350.00	27.805	21.380	49.185	7483.1	29.544	9731.8
360.00	28.411	21.609	50.020	7779.2	29.675	10228.
370.00	29.006	21.829	50.834	8076.6	29.794	10732.
373.15	29.191	21.896	51.087	8170.5	29.830	10893.
380.00	29.591	22.040	51.630	8375.1	29.905	11244.
390.00	30.166	22.243	52.408	8674.7	30.007	11765.
400.00	30.731	22.438	53.169	8975.2	30.101	12293.
425.00	32.106	22.895	55.001	9730.4	30.309	13645.
450.00	33.426	23.312	56.738	10490.	30.483	15042.
475.00	34.697	23.693	58.390	11254.	30.630	16481.
500.00	35.921	24.043	59.965	12022.	30.756	17961.
550.00	38.242	24.664	62.906	13565.	30.958	21033.
600.00	40.412	25.195	65.607	15117.	31.112	24247.
650.00	42.447	25.655	68.102	16676.	31.231	27591.
700.00	44.363	26.057	70.420	18240.	31.326	31054.

H_0^0 AND S_0^0 APPLY TO THE REFERENCE STATE OF THE SOLID AT ZERO DEG K

APPENDIX C

ERRATA IN PREVIOUS REPORTS

Our examination of NBS Reports 6297, 6484, 6645, and 6928 for errors is incomplete. Errors are corrected in later reports as we find them or as the result of being called to our attention by readers.

ERRATUM TO CHAPTER 5 OF NBS REPORT 6928, DATED 1 JULY 1960

Harold W. Woolley

In Chapter 5 of NBS Report 6928, the lowest known excited state of AlS was inadvertently listed as $^2\pi$ instead of $^2\Sigma^+$ (at. T_e = 23433.79 cm^{-1}). Also, at the end of that chapter, the centrifugal stretching constant D_e was listed as having the theoretical value 2.3×10^{-7} cm^{-1} instead of the observed 2.2×10^{-7} cm^{-1}. It is noted that Table A-33 of that report was computed for the ground state alone, using the theoretical rather than the observed value of D_e.

We are indebted to a private communication[1] for the pointing out of this error in the excited state and for a table computed with the observed D_e.

[1] John S. Gordon, private communication to C. W. Beckett, March 2, 1961.

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U. S. DEPARTMENT OF COMMERCE
Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

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Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

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Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Analytical Chemistry. Inorganic Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

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Radio Systems. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Space Telecommunications.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.


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